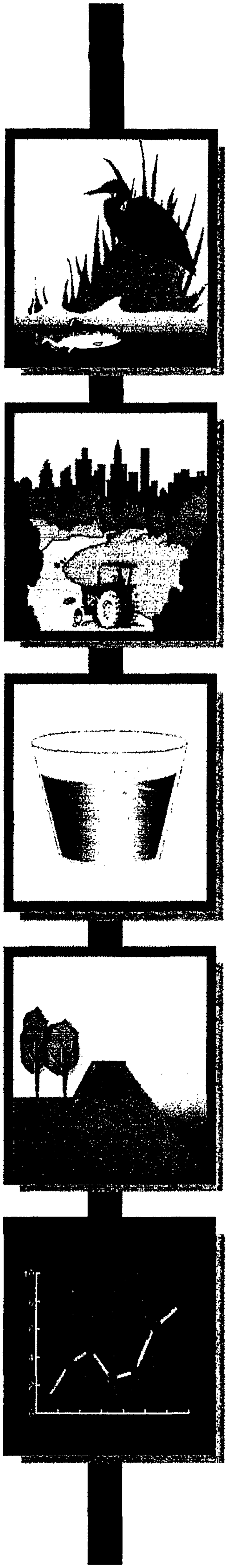

CALFED
BAY-DELTA
PROGRAM

Affected Environment and Environmental Impacts

Surface Water Hydrology

Draft Technical Report
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CALFED Bay-Delta Program
Draft Environmental Impact Report/ Environmental Impact Statement

Surface Water Supply and Water Management Affected Environment and Impact Assessment Technical Report

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The most general CALFED Bay-Delta Program (CALFED) surface-water supply and management objective is to improve the allocation of water for all beneficial uses. This allocation includes improving both instream flows (e.g., Delta outflow) necessary for ecological benefits and diversions required for water supply purposes. The primary water management goal of CALFED is to reduce the potential water allocation conflicts (i.e., mismatch between available water and beneficial uses) within the Bay-Delta tributary system. The secondary water management goal is to improve water supply reliability, which is defined as the ability to satisfy the assumed demands for water deliveries and instream flow requirements in every year.

IMPACT ASSESSMENT METHODS

The affected environment (i.e., existing conditions) for water management facilities and operations is described so that the relatively small (but very important) incremental effects of the CALFED alternatives on water management allocation and water supply reliability can be properly evaluated. The assessment methods for surface-water management use results from the DWRSIM model that was developed by the California Department of Water Resources (DWR) for general systemwide planning studies (see DWRSIM Modeling Technical Appendix). Because the monthly results are too detailed for programmatic impact assessment purposes, two general assessments of annual water management conditions are being used to evaluate CALFED alternatives:

- Water supply reliability is evaluated using simulated annual diversions (and deficits). Benefits are associated with increasing the diversions to meet the assumed demands (i.e., reduced deficits from assumed demands). The selected indicators of water supply reliability are the annual diversions in each tributary basin as well as total exports (i.e., deliveries) from the Delta.

- Water management allocation is evaluated using the simulated total beneficial uses of water, which include instream flows (and Delta outflows) in addition to diversions (and Delta exports). The selected indicator of water management allocation is the fraction of available water (i.e., unimpaired runoff) in each tributary basin (or in the Delta) allocated for specified instream flows or diversions.

The surface-water management assessment does not include an evaluation of the ecological benefits that may be achieved from alternative water management allocations. This is partially discussed in the fisheries and aquatic resources impacts assessment.

One indication of improved surface-water management would be increased benefits achieved from water allocated to instream flows. These benefits may be achieved by shifting the timing of instream flows from periods of relative surplus flow to periods of relative scarcity of water (by making diversions to existing or new storage facilities and later making releases from storage). Another indication of improved water management would be reduced impacts from water allocated to diversions (or Delta exports). This impact reduction may be achieved by the relocation of diversions to an area with reduced impacts on fisheries and aquatic resources or by shifting the timing of diversions from periods of higher impacts to periods of lower impacts.

These ecological improvements to water management cannot be directly simulated by the DWRSIM model, but are assumed to occur whenever possible within the overall water management and allocation alternatives that are described and discussed in this impact assessment.

The descriptions of water management conditions for the CALFED alternatives given in this programmatic assessment are based on DWRSIM model results. These model results provide a good approximation of many, but not all, of the factors involved in actual water management within the Bay-Delta watershed. More detailed discussion of the CALFED alternatives and the assumptions that were used for the CALFED alternative assessments are given in the DWRSIM Modeling Technical Appendix. The existing conditions (i.e., recent historical operating rules and facilities), assumed No-Action-Alternative conditions (i.e., simulated DWRSIM results) and likely changes expected with each CALFED alternative are described for each major tributary basin and for the Delta. The water management of the entire system is generally coordinated, although each tributary has unique water management facilities and features that must be accurately understood. The focus of the programmatic evaluation is, however, on water management in the Delta.

The available water in each tributary or in the Delta is allocated for instream flows or for diversions. If storage capacity is available, some of the inflow may be temporarily stored for later diversion or instream use. Some of the inflow may be in excess of that which can be used or stored, and is considered unallocated (i.e., excess or surplus). Some of the flows in excess of the specified instream flow requirements will most likely provide additional ecological benefits.

The potentially significant water supply and water management impacts include several interrelated reservoir storage, diversion, and streamflow conditions. Water management actions in each tributary basin will influence Delta water management conditions. Delta water management facilities may provide new opportunities for water management in tributary basins as well as in the export service areas. Tributary basins provide sources of runoff and stored water supply for the Delta. Increased storage capacity may augment Delta water supplies when instream flows and Delta outflow are most beneficial for ecosystem processes or for exports and water supply diversions. Each region receiving Delta exports has some local water supplies that reduce the demands for Delta exports. Increased storage, reclamation, and conservation may further reduce the need for Delta exports during dry conditions when water supply is low.

Alternative water supply management conditions will have a gradient of impacts and benefits that can be scored relative to the No-Action Alternative. The monthly DWRSIM model calculates changes in relatively few assessment variables (i.e., storages, diversions, and flows). These modeled changes will be interpreted for several potentially significant impacts. Because DWRSIM monthly model results are somewhat uncertain, changes must be interpreted relative to the assumed reliability of the model. Potential mitigation strategies for significant water management impacts will include:

- modified reservoir storage diversion rules to reduce the potentially significant impacts related to storage diversions;
- modified requirements for instream flows to reduce the potentially significant impacts related to reduced instream flows caused by upstream storage or diversions;
- modified diversion demand targets to reduce the potentially significant impacts caused by increased diversions during periods when aquatic organisms are vulnerable to entrainment.
- modified instream and adjacent habitat to compensate for changes in flow patterns and make affected species less vulnerable to flow-induced impacts (i.e., placing and cleaning gravels, reducing gravel mining, and promoting shaded riverine aquatic habitat).

SUMMARY OF NO-ACTION AND CALFED ALTERNATIVES WATER MANAGEMENT CONDITIONS

Results from the DWRSIM model have been evaluated and summarized in the technical report. The overall comparison of existing water management conditions for each tributary basin and the Delta are presented here as tables of the hydrologic conditions, simulated water allocation and reliability indicators, and average monthly water allocation in the Delta for the basic CALFED alternatives.

Table A gives the basic hydrological properties for each tributary basin. The watershed size and average annual runoff indicate the available water supply. The ratio of the existing reservoir volume to average annual runoff (storage ratio) indicates the ability to manage the runoff for seasonal or carryover purposes. Some tributaries have a relatively small storage ratio, indicating that the ability to manage water using storage is low. For example, Folsom Reservoir has a volume of 977 thousand acre-feet (TAF) with an average runoff of 2,675 TAF; the storage ratio is about 35%.

The San Joaquin River has a very low storage ratio of about 30% (i.e., 520/1,672 TAF). The Feather River storage ratio is about 50%, and the Sacramento River storage ratio is about 40%. The Clair Engle Reservoir volume is greater than the average annual runoff, so the Trinity River storage ratio of 195% is relatively high. The Stanislaus River storage ratio of 195% is also relatively high. The Delta inflow of about 22 million acre-feet (MAF) is quite large compared with the available storage in San Luis Reservoir of about 2 MAF, so the storage ratio for the Delta is only about 10%. All of the runoff from these tributaries are included in the DWRSIM model as calculated inflows; however, some of the reservoirs are not simulated directly in DWRSIM.

Table B gives average simulated No-Action Alternative surface water management indicators for each tributary basin simulated in DWRSIM and the Delta. The general water allocation conditions for each tributary can be described by the percent of average annual runoff that is needed for assumed (i.e., simulated) diversions and assumed existing instream flows. The Trinity River instream flows require about 27% of the average runoff. The diversions are actually exports to the Sacramento River and the Delta. Sacramento River diversions and instream flows are approximately equal, with each requiring about 30% of the average runoff. The remainder of the runoff is stored for later use or flows downstream as excess (i.e., unallocated) water to the Delta. The required instream flows on each tributary are also available as Delta inflow.

Table B summarizes the general use of storage as simulated for the No-Action Alternative. The average carryover storage indicates how much storage is available (if needed) in each tributary. The average storage release indicates how much storage is used for seasonal or carryover purposes. The Sacramento River (Shasta Reservoir), Feather River (Oroville Reservoir) and the Delta (San Luis Reservoir) have the highest average annual storage releases. The average carryover storage used indicates how much storage is used from one year to the next (generally in dry-year sequences). The Sacramento and Feather Rivers have the highest carryover storage use, with about 400 TAF each.

Table B gives the three water allocation indicators for the tributary basins and the Delta. The percent of inflow that is stored in the reservoir indicates the ability to manage runoff to supply water needs (for diversions or instream flows) in other months (or in dry years). This ratio is highest for the Trinity and Stanislaus Rivers, with more than 30% of the inflow stored in the reservoir. The percent of water (for diversions or instream flows) that is released from storage indicates the importance of storage for satisfying the water supply needs. This release ratio is slightly lower than 20% for the American and San Joaquin Rivers, and greater than 30% for the Tuolumne and Merced Rivers. The Trinity River has the highest release ratio of 38%.

The percent of runoff used is the overall summary of the water allocation condition for each tributary. This use ratio is the highest for the Trinity River because all available water is normally stored and then exported to the Sacramento River. The Feather River use ratio is only about 50%, but most of the water is used in the Delta to supply State Water Project (SWP) pumping and Delta outflow obligations. The Delta use ratio is about 60%, but the in-Delta diversions require an average of 5% of the inflow, so the overall Delta use ratio is about 65%. In addition, because the 1995 Water Quality Control Plan (WQCP) objectives for export/inflow ratio require a considerable amount of the Delta inflow (65% from February through June) to be reserved (i.e., allocated) for Delta outflow, the effective percent use for Delta inflow is closer to 90%.

Each CALFED alternative includes some variation in Delta conveyance facilities coupled with various levels of additional storage. At the programmatic level of evaluation, the changes in Delta conveyance facilities may not directly affect upstream water management operations of existing facilities because the modeling assumptions about required Delta outflows and allowable export/inflow ratios are unchanged between alternatives. However, as the Delta conditions likely to result from different conveyance facilities are better understood, some of the existing Delta requirements may change and there may be opportunities for different operations of upstream reservoir facilities. In addition, new storage facilities may allow different operations of the existing reservoir and Delta facilities.

As a result, there are no detectible simulated differences in existing tributary basin operations between Alternatives 1, 2, and 3 attributable to Delta conveyance facilities, but there may be substantial differences within each alternative attributable to different levels of additional storage. Because Alternatives 2 and 3 have larger potential new storage capacity than Alternative 1, there may be differences in upstream water management between these alternatives.

Table C gives a comparison of average monthly Delta water allocation conditions that have been approximated with DWRSIM model simulations for assumed operations under the three basic CALFED alternatives. The average monthly inflow, Delta export, and Delta outflow are given for each of several DWRSIM simulation results. The inflow that is not accounted for as exports or Delta outflow is used for in-Delta diversions. In some months there is a net gain of water from Delta rainfall-runoff.

The No-Action Alternative conditions are simulated with DWRSIM 472 and include the current SWP pumping limits that are less than physical pumping capacity. An average annual export of 6,404 TAF was simulated. DWRSIM 472B allows full physical pumping capacity whenever the inflow is sufficient to satisfy outflow requirements and the maximum allowed export/inflow ratio; however, without additional aqueduct storage, San Luis Reservoir cannot store much more Delta exports during winter months. An average annual export of about 6,656 TAF was simulated, which is about 250 TAF more than that exported under the No-Action Alternative. DWRSIM 510 was simulated to include additional upstream and aqueduct storage. The new storage facilities allowed more excess runoff to be captured upstream and allowed higher Delta exports to occur during periods having excess Delta inflows. An average annual export of 7,080 TAF was simulated. DWRSIM 472B and 510 could represent either Alternative 1 or Alternative 2.

DWRSIM 475 includes an isolated transfer facility with a capacity of 5,000 cfs, but the export/inflow ratio and the Delta outflow requirements remain the same as for the No-Action Alternative simulation. The simulated annual average exports of 6,759 TAF are about 100 TAF higher than under 472B. DWRSIM 500 includes the isolated facility with additional upstream and aqueduct storage facilities. The simulated average annual export of 7,183 TAF is about 100 TAF higher than the simulation of additional storage without the isolated transfer facility.

Table C indicates that the different simulations resulted in some shifts in the month's inflow, export, and outflow allocations. The inflow changes are the result of slightly modified upstream storage operations. The export changes are the result of slightly increased allowable pumping in some years. The outflow changes are only possible in months with excess outflow, above the outflow requirements and the allocated portion of inflow. Table C indicates that the shifts in average monthly inflows, exports, and outflows are relatively small. Nevertheless, these simulated monthly changes may provide substantial water supply benefits and eliminate fishery or water quality impacts resulting from the No-Action Alternative.

ALTERNATIVE 1

Tributary-basin water management may actually change because Alternative 1 will rely on both new reservoir storage and existing reservoir reoperation to increase Delta water supply during periods of delivery deficits. There are potential opportunities for modifying the monthly pattern of storage diversions and releases to match downstream flow requirements or diversions; however, these potential changes in the seasonal and year-to-year (e.g., carryover storage targets) reservoir operations have not been simulated with DWRSIM.

ALTERNATIVE 2

The potential changes in tributary-basin water management are the same as those described under Alternative 1. Because Alternative 2 would allow a larger additional aqueduct storage capacity to be constructed, the shifts in tributary-basin water management might be larger than under Alternative 1. None of these potential changes, however, are simulated in DWRSIM.

ALTERNATIVE 3 WATER MANAGEMENT CONDITIONS

The potential changes in tributary-basin water management are the same as those described under Alternative 2. None of these potential changes, however, are simulated in DWRSIM.

OBJECTIVES AND PURPOSE

The most general CALFED water management objective is to improve the management of water for all beneficial uses, which includes improving instream flows (e.g., Delta outflow) for ecological benefits and diversions for water supply purposes. The primary water management objective of CALFED is to reduce the potential mismatch between Bay-Delta water supplies and current or projected beneficial uses (water supply and instream flows) dependent on the Bay-Delta tributary system. The secondary water management objective is to improve the water supply reliability, which is defined as the ability to satisfy the assumed demands for water deliveries in every year. The purpose of the programmatic impact assessment is to identify potential changes in water management conditions, both beneficial and adverse, under each CALFED alternative relative to both the No-Action Alternative and existing conditions. In addition, the programmatic impact assessment identifies differences between the alternatives and provides information to assist decision makers in selection of a preferred CALFED alternative.

This technical report describes the affected environment for water supply and water management within the Bay-Delta watershed and presents the programmatic impact analysis results for the three basic CALFED alternatives. The affected environment (i.e., existing conditions) for water management facilities and operations are described so that the relatively small (but very important) incremental effects of the CALFED alternatives on water management conditions and water supply reliability can be properly evaluated. The general assessment methods are described, the potential significant effects are identified, and the significance criteria for judging the incremental changes in water management conditions are selected. The results from the programmatic impact assessment for water management are then presented relative to the No-Action Alternative conditions.

ASSESSMENT METHODS

The assessment methods for water management and water supply reliability use the DWRSIM model developed by DWR for general systemwide planning studies. The DWRSIM model assumptions and calculations are described in a separate technical appendix.

The DWRSIM model calculates the monthly diversions and riverflows at several river locations, and reservoir storage volumes for about ten major reservoirs for 73 years of monthly hydrologic conditions (e.g., water-years 1922 through 1994). The monthly results are too detailed for programmatic impact assessment purposes; therefore, a method for summarizing and evaluating the results is necessary. Two general types of water management assessment are being used to evaluate CALFED alternatives:

- Water supply reliability is evaluated using simulated diversions and delivery deficits. Benefits are associated with increasing the deliveries to meet the assumed demands (i.e., reduced deficits from assumed demands). The selected indicators of water supply reliability are the annual deliveries in each tributary basin as well as total exports from the Delta.

- Water management allocation is evaluated using the simulated total beneficial uses of water. The allocation includes improving instream flows and Delta outflows in addition to diversions for water supply purposes. The primary indicator of improved water management allocation is the utilization of more of the available water (i.e., unimpaired runoff) for either instream flow purposes or diversions. An indication of improved water management allocation is increased benefits from instream flows. These benefits may be achieved by shifting the timing of instream flows from periods of relative surplus flow to periods of relative scarcity of water. A similar indicator of improved water management allocation is reduced impacts from diversions. This impact reduction may be achieved by the relocation of diversions to an area with reduced impacts on fisheries and aquatic resources or by shifting the timing of diversions from periods of higher impacts to periods of lower impacts.

Figure 1 illustrates the overall water management allocation process that will be the basis for the programmatic impact assessment. The available water (i.e., inflow) is allocated for instream flows or for diversions. If storage capacity is available, some of the inflow may be temporarily stored for later diversion or instream use. Short-term flood control storage and subsequent release is assumed to occur but is not evaluated in this monthly planning framework. Some of the inflow may be in excess of that which can be used or stored, and is considered unallocated (i.e., surplus). Some of the flows in excess of minimum instream flow requirements will provide additional ecological benefits; therefore, the evaluation of CALFED alternatives should include consideration of the tradeoffs between additional instream flow benefits and additional diversion benefits. Diversion benefits are described in this document; potential instream flow benefits are described in the fisheries and aquatic resources assessment.

This water management technical report includes an overview of Central Valley water supply and a description of the existing water management in each major tributary basin, with a separate section for Delta water management conditions. The existing conditions (i.e., recent historical operating rules and facilities) assumed No-Action-Alternative conditions (i.e., simulated DWRSIM results) and likely changes expected with each CALFED alternative are described for each major tributary basin and for the Delta. Each tributary has unique water management facilities and features that must be accurately understood to be properly evaluated. The water management of the entire system is generally coordinated, although some of the tributaries are more independent of Delta conditions than others; however, the focus of the programmatic evaluation is on water management in the Delta.

The descriptions of water management conditions for the CALFED alternatives given in this technical report are based on the DWRSIM model results. These model results provide a good approximation of many, but not all, of the factors involved in actual water management within the Bay-Delta watershed. More detailed discussion of the CALFED alternatives and the assumptions for available DWRSIM model runs that were used for the CALFED alternative assessments are given in a separate technical report.

POTENTIAL IMPACTS AND MITIGATION

The potentially significant water supply and water management impacts include several interrelated reservoir storage, diversion, and streamflow conditions. Water management actions in each tributary basin will influence Delta water management conditions. Delta water management facilities may provide new opportunities for water management in tributary basins as well as in the export service areas. The potential connections between the tributary basins and Delta water management conditions include the following:

- Tributary basins provide sources of runoff and stored water supply for the Delta. This water enters the Delta as a result of uncontrolled runoff, releases for instream flows or Delta outflow requirements, reservoir spills, releases for export, and water transfers. Increased storage capacity may augment Delta water supplies when instream flows and Delta outflow are most beneficial for ecosystem processes or for exports and water supply diversions.

- Each region receiving Delta exports has some local water supplies from runoff, surface storage, recharge, water reclamation, and groundwater pumping. These local supplies reduce the demands for Delta exports. Increased storage, reclamation, and conservation may further reduce the need for Delta exports during dry years when water supplies are low.

CALFED alternatives will include changes to Delta management activities and facilities that may influence water management in other hydrologic regions:

- CALFED alternatives may increase the opportunities for exports during high flows (i.e., increased pumping capacity and aqueduct storage capacity) and reduce the need for exports during low-flow periods. This will most likely reduce impacts on aquatic ecosystem processes and species populations.

- CALFED alternatives may reduce Delta export impacts (i.e., fish entrainment and water quality degradation). This may allow increased exports and facilitate water transfers from upstream regions.

- CALFED alternatives may include Delta storage facilities, wetland restoration, reduced agricultural drainage, and modified channels and gates that will directly change water demands and channelflows in the Delta. These Delta management activities may thereby effect the potential quantity and quality of Delta diversions and exports.

POTENTIALLY SIGNIFICANT IMPACTS

All potentially significant water management impacts would be related to operational changes resulting from the CALFED alternatives rather than from effects of construction activities. There will be impacts from construction of new storage and conveyance facilities, but these will be described in other resource categories (i.e., land disturbance, habitat loss, noise). Several general types of potentially significant water management impacts can be identified:

- **Runoff:** Changes in runoff (to reservoirs or local streams) may be caused by upstream watershed management actions, including additional upstream storage, vegetation management, fire controls, and grazing controls. New groundwater management facilities for recharge to support conjunctive use would have effects on local runoff. Groundwater or other replacement supplies may allow upstream diversions to be reduced in some months of low runoff years (runoff would be increased).

- **Reservoir Storage**: Changes in reservoir storage may be caused by modified storage capacity or by different rules for allowable storage levels (increased diversions to storage). Flood control levels usually restrict diversions to storage during the winter period. Downstream diversion targets and flow requirements may also limit storage diversions. Changes in seasonal storage patterns may modify the flood control potential (flood risk). Evaporation loss is slightly increased at higher storage (i.e., increased surface area).

- **Riverflow:** Changes in riverflow may be caused by reservoir releases for instream flow benefits and downstream water supply diversions. The combination of all downstream demands relative to the available storage and runoff will generally control reservoir releases. The resulting flows will affect river hydraulics (depth, width, velocity) and sediment transport (gravel movement and flushing). Modified channels may affect the stage-discharge relationship and the associated flooding risks.

- **Diversions:** Changes in diversions for water supply (including direct use and local surface- or groundwater storage) may result from water use efficiency or other local water management programs. Exports from the Delta may be shifted in location or from months with higher potential aquatic organism entrainment effects to months with lower potential impacts. Reduced diversions may require increased groundwater pumping in the aqueduct service areas. Additional diversions may supply conjunctive use facilities or reduce groundwater pumping.

There are several potentially significant indirect impacts that may result from changes in Bay-Delta water management conditions:

- **Reservoir Storage:** Changes in reservoir storage may indirectly affect recreation, fish habitat, and wildlife habitat. Reservoir storage may influence release temperatures. Hydropower generation is generally increased with higher storage.

- **Riverflow:** Changes in riverflows may indirectly affect riparian or aquatic habitat conditions. Temperatures will be affected by flow. Flows may affect the groundwater recharge and storage. A method to judge the relative net benefits of changes in flow in each tributary each month should be used to evaluate potential benefits and impacts resulting from flow management associated with each CALFED alternative.

- **Diversions:** Changes in river diversions will change the entrainment effects on fish. Reliable fish screens may reduce the impacts of diversions. Relocating diversions may have beneficial effects. Shifting the timing of diversions may have beneficial effects.

- **Delta Outflow:** Changes in Delta outflow will have indirect effects on agricultural and export salinity. Changes in the location of the estuarine salinity gradient (i.e., X2) will have indirect effects on the estuarine habitat area for representative species. (If alternative channel configurations within the Delta are expected to shift the relationships between salinity and outflow [based on DWRSIM results], the new salinity relationships should be used in DWRSIM to estimate water supply changes that would be necessary to satisfy the WQCP objectives.)

- **Salinity:** Changes in flows may indirectly affect water quality. The salinity-flow relationship at Vernalis may be affected by upstream salinity management. A barrier at the head of Old River will most likely reduce the export salinity because more of the San Joaquin River salt load will be transported to the Bay. Riverflows may be used to estimate dilution indices for evaluating toxicity effects.

- **Location and Timing of Exports:** Changes in export location or monthly pattern will indirectly affect water quality because water quality is influenced by Delta outflow and diversion location (Tracy vs. Hood). Changes in exports will change the entrainment of fish and foodweb organisms.

- **Water Quality of Exports:** Delta channel flows along with assumed agricultural drainage flows and export locations will affect the export concentrations of salinity (electrical conductivity [EC], chloride [Cl], bromide [Br]) and dissolved organic carbon [DOC]. These are very important drinking-water-quality assessment variables.

SIGNIFICANCE CRITERIA

Significance of impacts may be determined by using thresholds for judging the magnitude of each potentially significant impact. It is more likely, however, that alternative conditions will have a gradient of impacts and benefits that can be scored relative to the No-Action Alternative. The monthly DWRSIM model calculates changes in relatively few assessment variables (i.e., storages, diversions, and flows). These modeled changes will be interpreted for several potentially significant impacts. Other resource topics may also use these simulated variables in their evaluations of the CALFED alternatives.

Because the DWRSIM monthly model results are somewhat uncertain, changes must be interpreted relative to the assumed reliability of the model. A change of greater than 10% in a single monthly value, a change of greater than 5% in a monthly average value, and a change of greater than 1% in an annual average value are probably the limits of detectable change for the DWRSIM model.

POTENTIAL MITIGATION STRATEGIES

Potential mitigation strategies for significant water management impacts are:

- Modify reservoir storage diversion rules to reduce the potentially significant impacts related to storage diversions.
- Modify requirements for instream flows to reduce the potentially significant impacts related to reduced instream flows caused by upstream storage or diversions.
- Modify diversion demand targets to reduce the potentially significant impacts caused by increased diversions during periods when aquatic organisms are vulnerable to entrainment.
- Modify instream and adjacent habitat to compensate for changes in flow patterns and make affected species less vulnerable to flow-induced impacts (i.e., placing and cleaning gravels, reducing gravel mining, and promoting shaded riverine aquatic habitat).

CENTRAL VALLEY WATER SUPPLY

The Bay-Delta receives runoff from the entire Sacramento and San Joaquin River basins. In addition, the Tulare Lake basin tributaries (i.e., Kern, Tule, Kaweah, and Kings Rivers) historically drained into the San Joaquin River during high-flow periods when Buena Vista and Tulare Lakes were full. Presently, only a portion of Kings River flows are diverted to the San Joaquin River during major runoff events. A large fraction of San Joaquin River water (from Friant Dam diversions) and Delta exports is delivered to the Tulare Lake basin. The Trinity Division of the Central Valley Project (CVP) includes a diversion from the Trinity River at Lewiston Lake to the Sacramento River at Keswick Lake; therefore, the water supply conditions for the entire Central Valley, as well as the Tulare Lake basin and the Trinity River upstream of Lewiston Lake, are included in the affected environment for assessment of water management impacts from CALFED alternatives.

The general water supply conditions can be summarized using annual average rainfall and snowpack measurements or using measured streamflow (i.e., unimpaired runoff) for each major tributary. The difference between annual average precipitation and unimpaired runoff represents water that is stored in soil moisture, evaporated from the soil or water surface, transpired by vegetation and trees, or infiltrated into the groundwater. Unimpaired runoff will be considered as the basis for the water management assessment of the CALFED alternatives. A water budget approach, like that used in DWR Bulletin 160-93 (California Water Plan Update) will be used to summarize the available water supply for each tributary basin.

Because CALFED is specifically concerned with water supply reliability and future opportunities to increase the managed water supply allocation for both instream purposes and diversion needs, the year-to-year and seasonal variations in the water supply must be accurately described. Managed water supply could be increased with some combination of expanded diversion opportunities and enlarged storage facilities to supply both seasonal and year-to-year (carryover) water needs.

UNIMPAIRED RUNOFF AND DELTA INFLOW

Unimpaired flow is estimated to consist of all rainfall and snowmelt runoff minus the water losses to evapotranspiration from natural soils and native vegetation and the net losses to groundwater storage (e.g., infiltration minus seepage). Because it is difficult to correct for the differences between past and present vegetation, unimpaired flow estimates are calculated from historical flow measurements and adjusted for upstream changes in reservoir storage and upstream diversions. DWR's Division of Planning estimates unimpaired flows for many Central Valley streams (California Department of Water Resources 1994 "California Central Valley Unimpaired Flow Data (1921-1992)-Third Edition"). Unimpaired flow from Trinity River at Lewiston is estimated from the measured flow at Lewiston adjusted for the Clair Engle Reservoir storage change and diversions to the Clear Creek tunnel. Unimpaired flows at the Tulare Lake basin tributary are similarly estimated from measured flows, change in storage, and diversion records. The annual unimpaired flows, as estimated by DWR, are provided in Table 1 for 1922-1994.

The water supply conditions within the Central Valley are commonly summarized with the unimpaired runoff estimates of four Sacramento River tributaries and four San Joaquin River tributaries. These are referred to as the Sacramento River index and the San Joaquin River index. When combined, the eight-river Central Valley index can be used to summarize available water supply conditions. The WQCP objectives for X2 location are partially governed by this eight-river index. The four-river unimpaired runoff values have been used to develop runoff indices for classifying water-years (i.e., Sacramento 40-30-30 index).

There are several tributaries in the San Joaquin and Sacramento River basins that are not included in the eight-river index. Unimpaired estimates for Sacramento River at Freeport plus Yolo Bypass, Cache Creek, and Putah Creek flows plus San Joaquin River at Vernalis plus eastside San Joaquin streams (i.e., Cosumnes, Mokelumne, and Calaveras Rivers) can be used to estimate the total unimpaired inflow to the Delta.

The range of annual Delta unimpaired inflow is quite large because of the extreme hydrologic variability that characterizes the Central Valley of California. The average annual unimpaired Delta inflow is about 28.5 MAF, but ranges from less than 7 MAF (1977) to greater than 70 MAF (1983). This 10-fold variation in unimpaired runoff indicates the need for substantial year-to-year water supply storage capacity.

The Sacramento River basin contributes the majority of the Delta inflow. The Sacramento four-river unimpaired index averages about 17 MAF and ranges from about 5 MAF to 38 MAF. The San Joaquin four-river unimpaired index averages about 5.5 MAF and ranges from 1.1 MAF to 15 MAF. The Trinity River unimpaired runoff at Lewiston averages about 1.2 MAF and ranges from 200 TAF to 3 MAF. The Tulare Lake basin unimpaired runoff averages about 2.9 MAF and ranges from 700 TAF to 8.6 MAF.

CENTRAL VALLEY WATER MANAGEMENT

Central Valley water management consists generally of allocating the available runoff for:

- maintaining sufficient water in tributary streams for ecological purposes,
- making direct diversions for export or in-basin water supply needs, or
- storing excess runoff in reservoirs and later releasing water for maintaining instream flows and making water supply diversions.

Multipurpose reservoirs have been constructed to provide flood control, hydropower, and recreational benefits, in addition to water supply benefits. Water management operations must balance the allocation of water and available reservoir storage among these multiple purposes.

Because the runoff, instream flow requirements, and diversion demands have substantial seasonal fluctuations, monthly as well as the year-to-year variations in the water supply conditions are important aspects of the CALFED water supply affected environment and impact assessment.

Figure 2 shows the general seasonal pattern of water management. Reservoirs are generally multipurpose facilities and must remain partially empty during the flood control season; therefore, there is often a limited storage capacity in months with the largest runoff potential. Additional storage capacity will generally allow more seasonal or year-to-year storage of excess runoff during wet periods (i.e., high-flow months). Diversions are normally made to satisfy water demands that peak during summer; therefore, only a portion of the water demands can be supplied with direct diversion of runoff. A substantial portion of the water demands must be supplied from reservoir storage releases (located upstream of the diversion or within the local water district). If instream flow requirements are greater than the natural runoff, water for maintaining these required flows must be supplied from upstream reservoir storage.

The existing water supply and water management facilities will be described for each of the tributary basins and the Delta for both historical and simulated No-Action-Alternative conditions. This description will provide the basis for evaluating the water management opportunities (and potential impacts) that may be achieved with the CALFED alternatives.

WATER MANAGEMENT ALLOCATION INDICATORS

The annual (water-year) water allocation can be summarized using six monthly totals: (1) the sum of the monthly inflows or available water supply; (2) the sum of the monthly required instream flows; (3) the sum of the monthly diversions; (4) the sum of all monthly storage increases (i.e., diversions to storage); (5) the sum of all monthly storage decreases (i.e., releases from storage); and (6) the sum of all excess flows (i.e., excess runoff and spills). These six water allocation totals can then be compared to summarize water management conditions. The ratio of storage increases to total inflow indicates the fraction of runoff that was stored that year for later beneficial use. The remainder of the runoff was used directly for instream flow and diversion purposes or was excess water that could not be used in the tributary basin because of storage limitations. Some of the water uses were satisfied by direct runoff. The remainder of the uses were dependent on the water storage facility. The percentage of the total uses supplied from reservoir storage releases is an important water allocation indicator. The ratio of the total uses (instream flows and diversions) to runoff indicates the fraction of runoff that was allocated for beneficial uses. This ratio may be greater than 1.0 in some dry years when carryover storage is used.

These monthly water allocation values and annual indices are only an approximation of the actual day-to-day reservoir operation and water use patterns. Flood control operations involve large variations in reservoir storage and releases within any particular month. The monthly average inflows, releases, and end-of-month storage values provide only a rough description of actual operations. Nevertheless, these monthly water allocation values and annual indices provide a general description of water management conditions that can be used for assessment of CALFED alternatives.

Trinity River Water Supply and Water Management

Overview

The Trinity River is a convenient tributary to begin the discussion of existing water management facilities because the water management of the Trinity River is relatively simple to describe. The annual Trinity River unimpaired runoff at Lewiston is about 1.2 MAF, with a range of between 200 TAF (1977) and 3 MAF (1983), as shown in Table 1. The CVP Clair Engle Reservoir has a storage capacity of about 2.5 MAF. The Clear Creek tunnel diversion to the Sacramento River basin has an annual maximum potential capacity of about 2.6 MAF (3,600 cubic feet per second [cfs]). The annual Trinity River instream flow requirements are currently 340 TAF, and the remainder of the runoff is normally stored in Clair Engle Reservoir and exported through the Clear Creek and Spring Creek tunnels to Keswick Reservoir on the Sacramento River. Because the combination of storage and export capacity is large relative to the runoff, almost all of the runoff from the Trinity River watershed above Lewiston is fully utilized for instream flows or export. Excess flows (i.e., spills) in the Trinity River have occurred infrequently.

There is, therefore, little opportunity to increase the utilization of Trinity River runoff, although the water supply may be allocated differently in the future (e.g., instream flows may increase and exports may correspondingly decrease). The monthly pattern of water use may also change in the future (i.e., the monthly instream flow requirements or exports may shift to different months). Change in the monthly pattern of use could change the seasonal reservoir storage and release patterns, as well as the monthly hydropower generation and water temperatures and other environmental effects.

Watershed Runoff Characteristics

The Trinity River watershed (Figure 3) upstream of Lewiston has a drainage area of about 692 square miles. The average basin runoff of 1.2 MAF is therefore equivalent to about 36 inches per year.

Figure 4 shows the monthly distribution of runoff (i.e., probability of exceedance) under the No-Action Alternative and the current monthly instream flow requirements for the Trinity River. The graph shows the monthly 10% exceedance flows and the current monthly instream flow requirements (i.e., a total of 340 TAF per year). The monthly flows generally increase from November through May, with peak flows generally occurring in April or May. Monthly flows decrease in June and July and are quite low from August through October. The monthly instream flow requirements are less than the 90% exceedance flow values for most months. The peak instream flow requirement in May is about equal to the 90% exceedance flow. The instream flows maintain higher-than-natural flows, however, in summer months.

WATER MANAGEMENT FACILITIES

Clair Engle Lake, completed by the U.S. Bureau of Reclamation (Reclamation) in 1960, has a storage capacity of about 2.5 MAF. Trinity Powerhouse, with a discharge capacity of approximately 3,900 cfs, is operated primarily as a peaking plant and does not run continuously, except during periods of high releases. The powerhouse intake is located at an elevation of about 2,100 feet. Excess reservoir storage is released through the spillway (an elevation of 2,370 feet).

Lewiston Lake creates an afterbay reservoir for the Trinity Powerhouse and serves to regulate releases from Clair Engle Lake. Completed by Reclamation in 1962 as a part of the Trinity River division of the CVP, Lewiston Dam is a 91-foot-high earth-fill structure providing a reservoir capacity of 14,600 af and a surface area of approximately 735 acres. Most of the water released from Lewiston Lake is diverted though the Clear Creek tunnel to the Judge Francis Carr Powerhouse, which is operated intermittently for peaking purposes. When the powerhouse operates at full capacity, approximately 3,600 cfs are drawn through the Clear Creek tunnel intake that is located near Lewiston Dam. Lewiston Lake water levels are held fairly constant through balanced releases from Clair Engle Lake and diversions from Lewiston (i.e., the Trinity and Judge Francis Carr powerhouses are operated concurrently).

RESERVOIR STORAGE OPERATION

Figure 5 shows the historical monthly storage 10% exceedance values for 1972 to 1992 (recent historical period). Maximum storage each year occurs in May or June, following the months with highest runoff. Clair Engle monthly storage usually decreases from June through November and usually increases from December through May. A greater increase in storage is possible with higher inflows, although less of an increase is possible if the storage is already near the maximum flood control storage level.

The maximum storage in Clair Engle Lake is currently limited to 1.85 MAF at the end of October through the end of December, and increases to 1.9 MAF at the end of January, 2.0 MAF at the end of February, and 2.1 MAF at the end of March as required by the Division of Safety of Dams for maximum spillway capacity (to provide necessary flood regulation volume). An increase in storage during these months is possible only if the reservoir storage is lower than the maximum allowable storage level. Storage can increase to 2.5 MAF by the end of April.

An annual drawdown of approximately 500-800 TAF usually occurs during summer and fall. For water-years 1967-1991, carryover (end of September) reservoir storage varied from a maximum of 2.16 MAF in 1983 to a minimum of 242 TAF in 1977, with an average carryover storage of 1.69 MAF. The carryover storage is often used to characterize the water supply available for subsequent dry years, although only a portion of the carryover storage plus the actual runoff would be used in to guard against a worst-case sequence of dry years (i.e., drought conditions).

REGULATED FLOWS AND DIVERSIONS (EXPORTS)

The Trinity River runoff was historically (1963-1991) stored in Clair Engle Lake during spring and exported in summer to supplement the Sacramento River water supply and provide hydropower benefits. Annual diversions from the Trinity River for water-years 1967-1991 averaged 1.03 MAF of the 1.34 MAF of unimpaired Trinity River flow, ranging from a minimum of 217 TAF exported in 1978 to a maximum of 1.77 MAF exported in 1974.

Figure 6 shows the monthly historical (1962-1992) exceedance values for Trinity River exports. The greatest historical exports have occurred from July to September, corresponding to the highest demands for water supply on the Sacramento River and also the greatest demands for hydropower. Historical exports were lowest from November to April when the water supply demands on the Sacramento River were lowest.

Figure 7 shows the monthly historical exceedance values for regulated flow below Lewiston Lake for 1971-1991. Since completion of the Trinity River facilities, the only historical flows greater than estimated instream flow requirements (i.e., spills) occurred in 1974, 1983, 1984, and 1986. The annual instream flow requirements ranged from 120 TAF to about 340 TAF, with monthly flows that can be adjusted by the U.S. Fish and Wildlife Service (USFWS). Flows are regulated at about 300 cfs most of the time.

HISTORICAL WATER MANAGEMENT ALLOCATION

Water diversions for export from the Trinity River are different from most water supply diversions because the target diversions (i.e., demands) are adjusted to match the available water supply on the Trinity River and the water supply demands on the Sacramento River and in the Delta. Nevertheless, the allocation of Trinity River water for instream uses and for water supply diversion uses can be calculated and summarized. The water management allocation for the Trinity River runoff can thereby be characterized and compared to other tributary water management allocations.

The current (since 1991) Trinity River instream flow requirements are different from most instream flow targets because the Trinity River instream flow requirements are constant for any water supply condition (i.e., water-year type), whereas most instream flow requirements increase with available water supply conditions. It is therefore easy to determine the instream flow allocation for the Trinity River as 340 TAF. As a fraction of runoff, the current Trinity River instream flow allocation requires between about 11% of the highest annual runoff (1983) to about 150% of the lowest annual runoff (1977).

The monthly historical water allocation pattern for the Trinity River illustrates the use of large reservoir storage and large diversion (i.e., export) capacity for managing the natural variations in the hydrology (i.e., runoff). Runoff is allocated to three general water management purposes:

instream flows, diversions, or reservoir storage (for later beneficial use). If the monthly runoff exceeds the monthly instream flow requirement and the monthly diversion target (or capacity) and available storage capacity, the excess runoff must be spilled downstream (where the excess flows may provide instream benefits or be diverted and used). This spilling of excess runoff has occurred only infrequently on the Trinity River but may be a much larger fraction of available water on other tributaries.

When monthly runoff exceeds the monthly requirements for instream flow and export, the excess inflow is stored in the reservoir (if storage space is available) for subsequent use. When the runoff is less than the monthly requirements for instream flow and export, the reservoir storage is reduced (i.e., released) to supply the necessary water. This is the essence of water management on the Trinity River and is the general water allocation procedure used for other tributary basins.

Figure 8 shows the recent period (1982-1991) of monthly historical inflow, reservoir storage, storage releases, instream flow requirements, and exports to the Sacramento River. The monthly flows and storage are shown on the same graph to illustrate the relative magnitude of the available storage and runoff. The maximum monthly storage values permitted by flood control rules are also shown to indicate the available storage space in Clair Engle Reservoir. Spills occurred in 1983, 1984, and 1986. The remainder of the Trinity River runoff was used, either directly or after release from storage, for instream flows or for exports.

Table 2 gives the annual historical (1962-1991) water allocation indices for the Trinity River. The average inflow for 1962 to 1991 was 1,332 TAF. The average total water use was 1,222 TAF. This is a very large fraction of the total inflow (i.e., 92%). Spills occurred in only 5 years, with an average annual excess flow of 78 TAF (i.e., 8 % of inflow). The average historical export (beginning in late 1963) was 988 TAF (74% of inflow). The average historical instream flow allocation (estimated from monthly flow records) was 233 TAF (18% of inflow). The average annual storage increase (i.e., sum of monthly diversions to storage) was 630 TAF. This represents an average of 47% of the runoff that was stored in Clair Engle Reservoir prior to use. The average release from storage for water use was 640 TAF. The average ratio of storage release to total uses for the Trinity River was 52% (i.e., 640/1222); therefore, slightly more than half of the total water use on the Trinity River was dependent on the reservoir storage operations.

Table 2 also gives the historical carryover storage values. The average for 1962-1991 was 1,724 TAF. The annual sequences of carryover storage and total storage diversions and releases indicate that higher storage releases for water uses are made in dry years and greater storage accumulation occurs in wet years (to save for dry years). The average use of carryover storage was about 180 TAF (used in about half of the years). Subtracting this carryover storage use from the total annual storage releases indicates that the average seasonal storage release was 460 TAF. The total use (instream flows and exports) is greater in wet years, but the fraction of runoff that is used is usually smaller in wet years because more of the runoff is generally stored for use in subsequent years. These annual water allocation values (indices) provide a good summary of the existing water management of the Trinity River. Potential changes in the water allocation and water supply management opportunities resulting from CALFED alternatives will be described relative to these existing Trinity River water management patterns.

NO-ACTION ALTERNATIVE WATER MANAGEMENT ALLOCATION

Table 3 gives the simulated No-Action Alternative annual water allocation values for the Trinity River. The average inflow for 1922 to 1994 was 1,254 TAF. The average total simulated water use was 1,232 TAF. This is a very large fraction of the total inflow (i.e., 98%). The average simulated export was 892 TAF (71% of inflow). The average simulated instream flow was 340 TAF (27% of inflow). The average simulated storage increase was 454 TAF (36% of runoff). The average simulated release from storage for water use was 467 TAF. The average simulated carryover storage was 1,329 TAF and the average annual use of carryover storage was 164 TAF.

The average ratio of storage release to total uses for the Trinity River was 38%; therefore, somewhat more than one-third of the simulated No-Action Alternative total water use on the Trinity River is dependent on the reservoir storage operations. This fraction is somewhat less than the historical amount because the historical instream flows were less and the historical exports were delayed until the end of each water-year. The simulated No-Action Alternative exports are more uniformly distributed throughout the year so that more of the exports are can be supplied directly by inflow.

Figure 9 shows the 1982-1991 period of monthly inflow, reservoir storage, reservoir releases, instream flow requirements, and diversions (i.e., exports), for the simulated No-Action Alternative (DWRSIM 472). The inflows are the same as those of the historical record, but the monthly diversions are different. There is less simulated seasonal storage because the exports are more uniform.

Figure 10 shows the simulated No-Action Alternative monthly exceedance values for Trinity River exports. In comparison with the historical exports (Figure 6), the simulated monthly export pattern is more evenly distributed between March and August. The peak simulated No-Action Alternative exports occur in June and July. The shift from the historical export pattern is partially the result of the coldwater management strategy for the Sacramento River below Keswick Reservoir.

Figure 11 shows the simulated No-Action Alternative monthly Trinity River flows. Because there are very few periods with spills, the monthly flows are equal to the instream flow requirements.

Figure 12 shows the simulated No-Action Alternative annual water allocation for the Trinity River. Because of reservoir storage operations, the annual use sometimes exceeds the annual runoff (requiring a decrease in carryover storage from one year to the next). The allocation of runoff between instream flows and exports is clearly shown in this figure because the assumed instream flow requirement is a constant 340 TAF.

Figure 13 shows the simulated No-Action Alternative Clair Engle Reservoir carryover storage compared with the historical carryover storage values. The carryover patterns are very similar. Carryover storage is a good indicator of the use of the reservoir for year-to-year storage.

When the carryover storage declined, the storage was used to augment instream flows and exports during the year. If carryover storage increased, excess runoff was used to refill the storage. For the No-Action Alternative, an average of 160 TAF of carryover storage was used to augment uses in the following year. Because the average total storage releases of 467 TAF include this carryover storage use, the average seasonal use of storage was about 300 TAF for the No-Action Alternative.

Figure 14 shows the simulated No-Action Alternative annual exports compared with the historical exports. Because the exports are largely controlled by the available runoff, the export values are quite similar. The Trinity River exports are considered as one of the inflows for the Sacramento River basin water management allocation.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Each alternative includes some variation in Delta conveyance facilities coupled with various levels of additional storage. At the programmatic level of evaluation, the changes in Delta conveyance facilities may not appear to directly affect upstream water management operations of existing facilities because the modeling assumptions about required Delta outflows and allowable export/inflow ratios are unchanged between alternatives. However, as the Delta conditions likely to result from different conveyance facilities are better understood, some of the existing Delta requirements may change and there may be opportunities for different operations of upstream reservoir facilities. In addition, new storage facilities may allow different operations of the existing reservoir and Delta facilities.

As a result, there are no detectible simulated differences in Trinity River operations between Alternatives 1, 2, and 3 attributable to Delta conveyance facilities, but there may be substantial differences within each alternative attributable to different levels of additional storage. Because Alternatives 2 and 3 have larger potential new storage capacity than that of Alternative 1, there may be differences in Trinity River water management between these alternatives; however, the DWRSIM model assumes that Trinity River operations are not affected by the CALFED alternatives.

Trinity River water management may actually change because Alternative 1 will rely on both new reservoir storage and existing reservoir reoperation to increase Delta water supply during periods of delivery deficits. There are potential opportunities for modifying the monthly pattern of Trinity River exports to match the diversions to a new storage facility or to use Clair Engle as a "drought- reserve" storage facility by reducing Trinity River exports in wet years and increasing Trinity River exports in dry years; however, these potential changes in the monthly export pattern and the seasonal and year-to-year (e.g., carryover storage targets) reservoir operations have not been simulated using DWRSIM.

The Trinity River Instream Flow Study and environmental report are being prepared by USFWS and Reclamation. These documents explore the range of potential instream flows and reallocation of water from exports to instream flows. Any reoperation of Clair Engle Reservoir storage to provide a different seasonal or year-to-year export pattern will have to be consistent with the Instream Flow Study recommendations. Temperature control on the Sacramento River may also require specific monthly Trinity River export patterns. Experience with the recently completed (1997) temperature control device (TCD) in Shasta Lake may modify the constraints on Trinity River exports; therefore, no changes in Trinity River operations, instream flows, or monthly export patterns are being evaluated for the CALFED programmatic EIR/EIS.

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The potential changes in Trinity River water management under Alternative 2 are the same as those described for Alternative 1. Because Alternative 2 would allow the construction of a larger additional aqueduct reservoir storage capacity, the shifts in Trinity River water management might be larger than under Alternative 1. None of these potential changes, however, are simulated in the DWRSIM results.

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

The potential changes in Trinity River water management under Alternative 3 are the same as those described for Alternative 2. None of these potential changes, however, are simulated in the DWRSIM results.

SACRAMENTO RIVER WATER SUPPLY AND WATER MANAGEMENT

OVERVIEW

The Sacramento River water supply and water management is very important for Delta conditions because a major fraction of Delta inflows originates from the Sacramento River and tributary streams. Exports from the Trinity River flow into Whiskeytown Lake, located on Clear Creek, and then into Keswick Reservoir, located just downstream of Shasta Dam. The major storage reservoir in the Sacramento River basin is Shasta Lake, with a storage capacity of about 4.5 MAF.

The annual average Sacramento River runoff at Bend Bridge, located upstream of Red Bluff, is about 8 MAF, with a range of between 3.3 MAF (1924) and 17.3 MAF (1983), as shown in Table 1. The Sacramento River at Bend Bridge includes runoff from several tributary streams (e.g., Clear, Cow, Bear, Battle, and Cottonwood Creeks). The Trinity River exports to the Sacramento River basin enter upstream of Bend Bridge, but are not included in the runoff values.

The instream flow requirements are represented by the "Navigation Control Point" near the downstream end of the Sacramento River, just upstream of the Feather River. The instream flow requirement is 5,000 cfs, except in low-runoff years. The average instream flow requirement is therefore approximately 3.6 MAF. The average total diversions between Shasta Lake and the Feather River are estimated to be about 3.2 MAF.

Because the storage capacity of Shasta Lake is only about half of the annual average runoff, and because much of the runoff enters the Sacramento River downstream of Shasta Lake, a considerable fraction of the available water that is in excess of the diversion demands and instream flow requirements cannot be stored and is unallocated in the Sacramento River basin (although some may be used for Delta diversions, exports, or required Delta outflow). There is the potential for diverting and allocating more of this excess water for instream flow or diversion uses if additional storage capacity is developed in the Sacramento River basin as part of CALFED alternatives.

WATERSHED RUNOFF CHARACTERISTICS

The Sacramento River watershed upstream of Shasta Reservoir has an area of about 6,420 square miles. The Sacramento River watershed upstream of the Feather River is about 14,050 square miles (Figure 15).

Table 4 gives the historical runoff and water management index values for the Sacramento River basin upstream of the Feather River for 1945-1991. The average annual inflow to Shasta Reservoir is about 5.9 MAF, and the total runoff upstream of the Feather River is about 11 MAF;. therefore, about half of the runoff is potentially controllable in Shasta Reservoir and the other half is runoff from the tributary streams. The tributary streams have very limited reservoir storage; therefore, the runoff follows the natural (unimpaired) pattern with some local diversions for irrigation in the downstream sections of the tributaries.

Figure 16 shows the monthly exceedance values for unimpaired inflow to Shasta Lake for 1972-1992. The monthly flows generally increase from November through March, with peak flows generally occurring in March. Snowmelt is not a dominant component of Shasta Lake inflow. Monthly flows decrease in April and May and are less than 5,000 cfs from June through October. The flows in these summer and fall months are relatively constant (i.e., between 3,000 and 4,000 cfs) because the volcanic geology of the watershed provides a large groundwater component that sustains the streamflow.

WATER MANAGEMENT FACILITIES

Shasta Lake stores and releases flows of the Sacramento, Pit, and McCloud Rivers. Shasta Dam is a 602-foot-high concrete gravity structure providing a storage capacity of approximately 4.5 MAF. Water can be released from Shasta Lake through the powerhouse, the low-level or high-level river outlet, or the spillway.

Keswick Reservoir, a 159-foot-high concrete gravity structure, is located 8 miles downstream of Shasta Lake. With a storage capacity of approximately 25 TAF, Keswick is a regulating reservoir for releases from the Spring Creek and Shasta Powerhouses. The storage and elevation in Keswick Reservoir are maintained by concurrent operation of the powerhouses. The Keswick Powerhouse has a capacity of approximately 16,000 cfs.

Whiskeytown Lake, located on Clear Creek, has a storage capacity of approximately 240 TAF. Although Whiskeytown Lake collects some natural inflow from Clear Creek (about 350 TAF), most of its inflow comes from the Trinity River exports. Whiskeytown is operated with only limited seasonal storage fluctuations. Releases to Clear Creek of about 100 TAF per year provide instream flows and some downstream diversions. Some water supply diversions are made directly from Whiskeytown Lake. Most of the Trinity River exports and Clear Creek inflows are diverted through the Spring Creek tunnel and Powerhouse to Keswick Lake.

The Red Bluff Diversion Dam (RBDD) is located on the Sacramento River just downstream of Red Bluff. Diversions are made to the Tehama-Colusa Canal (TCC) and Corning Canal, with a maximum annual diversion of about 600 TAF. Several smaller diversions occur between Keswick and Red Bluff. The RBDD gates are allowed to be closed only from May 15 through September 15 because of concerns for winter-run chinook salmon passage, so the diversions are limited to the pumping capacity of about 150 cfs at the beginning and end of the irrigation season. Some water for the TCC is obtained from Stony Creek (Black Butte Reservoir) when excess water is available.

The major diversion downstream of Red Bluff is the Glenn-Colusa Irrigation District (GCID), located downstream of Hamilton City, with an annual diversion of about 800 TAF. There are several additional diversions along the Sacramento River, with a combined annual diversion of about 1.85 MAF, so that the estimated annual diversions for the entire Sacramento River basin above the Feather River mouth is estimated to be about 3.25 MAF. The historical estimates given in Table 4 are considerably lower (maximum of about 2 MAF).

RESERVOIR STORAGE OPERATIONS

Figure 17 shows the historical monthly Shasta Lake storage exceedance values for 1972 to 1992. Maximum storage each year occurs in April or May, following the months with highest runoff. The maximum flood control storage level is reduced in wet years to provide greater flood control storage space. Shasta Lake monthly storage usually decreases from May through September and usually increases from January through April. Because Shasta Lake has a relatively small maximum storage capacity during the winter flood control season, much of the winter storm runoff cannot be captured in Shasta Lake.

The relatively early spring runoff must be stored for summer irrigation diversions and releases for Delta outflow and exports. The seasonal storage and subsequent releases from Shasta Lake average about 1.5 MAF. The average annual inflow for 1967-1991 was 6 MAF. Shasta Reservoir also provides some year-to-year carryover storage in drought periods. The lowest carryover storage of 630 TAF occurred in 1977. Table 4 gives the historical carryover storage for Shasta Lake.

REGULATED FLOWS AND DIVERSIONS

Releases from Keswick Lake originate from Shasta Lake releases and Spring Creek releases from Whiskeytown. Keswick releases are made for downstream uses, including diversions along the Sacramento River; minimum required flows at the Navigation Control Point; and Delta uses for outflow, diversions, and exports. Some of the Keswick releases result from flood control operations when the monthly maximum Shasta and Clair Engle Reservoir storage capacities are exceeded.

Although there are instream flow requirements at Keswick, they are generally less than 5,000 cfs (monthly volume of about 300 TAF) and do not often control releases from Keswick. Additional releases for temperature control in the Sacramento River between Keswick and Red Bluff have been made since 1991 in the summer and fall months. The regulated Keswick releases are much higher than unimpaired flows during the summer irrigation season.

Figure 18 shows the historical monthly diversions at Red Bluff Diversion Dam (1976-1986) and at Glenn-Colusa Irrigation District (1960-1986). There are other diversions along the Sacramento River but these two diversions indicate the pattern of use.

Figure 19 shows the historical monthly exceedance flows at Keswick for 1972-1992. The seasonal water management operations for downstream diversions and Delta requirements are clearly evident in the monthly release patterns (i.e., May through September).

HISTORICAL WATER MANAGEMENT ALLOCATION

Table 4 gives the annual historical water management allocation values for the Sacramento River. The historical period from 1945 to 1991 included Trinity exports. The average Shasta inflow for 1945 to 1991 was about 5.9 MAF. The average Shasta carryover storage was 2.8 MAF. The average annual storage diversion was 1.4 MAF (about 25% of the Shasta inflow). The average annual storage release was also about 1.4 MAF, of which an average of about 350 TAF were carryover storage releases and the remaining 1 MAF were seasonal storage releases. Because the historical diversions and instream flow requirements are uncertain, estimating the fraction of runoff that was used for beneficial uses is difficult for the historical conditions.

The historical water allocation for the Sacramento River basin upstream of the Feather River has satisfied instream flow requirements at Keswick and the navigation control point, as well as supplied diversions for water supply along the Sacramento River. Additional releases from Shasta have been made to satisfy Delta outflow requirements and provide water for CVP exports at the Tracy Pumping Plant.

Historical diversions along the Sacramento River are somewhat difficult to estimate because direct measurements of all diversions is not available. A combination of streamflow measurements and diversion measurements have been used. The current annual estimate, used in DWRSIM for the No-Action Alternative, is about 3.25 MAF. The flow requirements at the Navigation Control Point can be approximated as 5,000 cfs in most years, with 4,000 cfs required in dry years and 3,500 cfs required in critical years; therefore, the allocation of Sacramento River runoff and Trinity River exports for instream uses and for water supply diversion uses can be calculated and summarized.

When monthly runoff exceeds the monthly requirements for instream flow and export, the excess inflow is stored in the reservoir (if storage space is available) for subsequent use. When the runoff is less than the monthly requirements for instream flow and export, the Shasta or Clair Engle Reservoir storage is reduced to supply the necessary water. This is the essence of water management on the Sacramento River and is the general water allocation procedure used for all tributary basins.

Figure 20 shows the 1982-1991 period of monthly historical inflow, Shasta Reservoir storage, exports from the Trinity River, releases from storage, and total downstream uses for instream flow and diversions. The maximum monthly storage for flood control purposes is shown to indicate the available storage space in Shasta Reservoir. Excess runoff occurs frequently because the available storage in Shasta is relatively small relative to the runoff. Storage releases are often made during summer to supply downstream diversions, Delta outflow, or Delta exports.

NO-ACTION ALTERNATIVE WATER MANAGEMENT ALLOCATION

Table 5 gives the annual Sacramento River water management allocation summary as simulated for the No-Action Alternative. The average simulated Shasta inflow for 1922-1994 was 5.5 MAF. The total Sacramento River inflow above the Feather River was about 11 MAF. The Shasta inflow averages about half of the total Sacramento River inflow. The average simulated Trinity export was about 900 TAF, increasing the total water available for allocation in the Sacramento River basin by about 8%.

Total simulated diversions averaged 3.25 MAF and the average simulated instream flow allocation at the Navigation Control Point was 3.1 MAF. When these two beneficial uses are added together, the total annual Sacramento River uses range from 4.9 MAF to about 7.9 MAF, with an average total use of 6.7 MAF. The fraction of total runoff (not including Trinity exports) that is used for beneficial uses therefore ranges from less than 50% in wet years to more than 100% in several dry years.

The No-Action Alternative simulation results indicate that an average of 1.5 MAF of the Shasta inflow are stored and later released for beneficial uses. The simulated carryover storage sequence indicates that an average of about 375 TAF of carryover storage are used to augment water supply in dry years. The remaining 1.1 MAF are used for seasonal storage and releases. The direct uses of runoff for instream flow and diversions in the Sacramento River basin averages 5.4 MAF;

therefore, the remaining 1.3 MAF must be supplied from Trinity exports and Shasta storage releases.

Figure 21 shows the simulated No-Action Alternative monthly water allocation for the Sacramento River above the Feather River. The total runoff, Trinity River export, and Shasta storage release are compared with the total uses (instream flows and diversions). The inflows and exports are often greater than beneficial uses in winter months; however, during summer months, the storage releases from Shasta are needed to supply beneficial uses along the Sacramento River and downstream in the Delta.

Figure 22 shows the distribution of monthly Keswick exceedance flows simulated for the No-Action Alternative. The maximum monthly instream flow requirements at Keswick are shown for reference. Although there are instream flow requirements at Keswick (i.e., between 3,250 cfs and 5,500 cfs from September through April that are triggered by Shasta carryover storage), they are generally less than the releases being made for downstream uses. The simulated releases during the irrigation season of May through September are relatively uniform from year to year, with maximum releases in July of between 10,000 cfs (600 TAF) and 16,000 cfs (960 TAF),which is the Keswick Powerhouse capacity. Higher releases during these months are also beneficial for temperature control between Keswick and Red Bluff.

Figure 23 shows the monthly distribution of simulated Sacramento River diversions above the Feather River for the No-Action Alternative. The diversion pattern follows the irrigation demands from April through September. Diversions in the remaining months are less than 100 TAF (1,500 cfs) The maximum monthly diversions of about 600 TAF (10,000 cfs) occur in June, July, and August.

Figure 24 shows the distribution of monthly simulated flows at the Navigation Control Point. The instream flow requirements are often one of the controlling factors in summer and fall months. Shasta storage releases are used to provide water for diversions along the Sacramento River and maintain the specified flows at the Navigation Control Point.

Figure 25 summarizes the annual Sacramento River water allocation as simulated for the No-Action Alternative. The available water (Trinity exports, Shasta inflows, and local tributary runoff) is usually more than the combined uses for instream flow and diversions. Some fraction of this excess water is used in the Delta, and the remainder contributes the surplus Delta outflow, which may provide additional ecological benefits in the estuary and Bay.

Figure 26 shows that the No-Action Alternative simulation of Shasta carryover storage sequence is similar but not identical to the historical Shasta carryover storage sequence. Both diversions along the Sacramento River, Delta exports, and Delta outflow requirements have substantially increased from the historical conditions, modifying the necessary Shasta storage operations.

Figure 27 indicates that the No-Action Alternative simulation of annual Sacramento River diversions are somewhat greater than the historical estimates of diversions.

The No-Action Alternative simulation indicates that an additional 1 MAF of storage releases and Trinity exports (i.e., managed flow releases) are made beyond that required for Sacramento River uses. These releases are presumably used in the Delta for in-Delta diversions, exports, and Delta outflow; however, the simulation results indicate that an average of 615 TAF of these managed Trinity River exports and Shasta storage releases are made during months with surplus Delta outflow and are therefore not needed for any Delta water uses. Table 5 indicates that these surplus managed releases are less than 100 TAF in several dry years, but there are substantial surplus Trinity River exports and Shasta storage releases in the majority of years. Some of these surplus Sacramento River managed flow releases are the result of flood control storage reductions, but some of this simulated water supply could possibly be reoperated to better match actual downstream water uses.

EFFECTS OF A NEW SURFACE STORAGE FACILITY

The direct effects of a Sacramento basin surface storage facility have been simulated with the DWRSIM model for one set of possible operating rules. The range of potential new diversion opportunities can be estimated from the DWRSIM-simulated navigation control flows. Monthly diversions to the surface storage facility are assumed whenever the No-Action Alternative flows are greater than a specified minimum diversion threshold (assumed equal to the required navigation flow) and whenever Delta surplus outflow is also simulated. The new diversion capacity is assumed to be 5,000 cfs (300 TAF per month).

Figure 28 shows the monthly new diversion opportunity for 1982-1991 as controlled by the navigation flow minimum and surplus Delta outflow. The new monthly diversions would reduce the monthly Sacramento River flows at the Navigation Control Point (Figure 24). New diversions would not be made during months when the export/inflow ratio controls Delta exports because the reduced inflow would reduce allowable exports; however, only surplus Delta outflow has been checked in this simple evaluation of potential new diversion opportunities.

Figure 29 indicates that the simulated annual potential for new diversions is quite large (see Table 6 for annual values). The simulated new diversion opportunity depends on the excess Sacramento River runoff (and surplus Delta outflow) and new reservoir storage capacity, as well as the assumed flow threshold for diversion. For example, if the navigation flow requirement (5,000 cfs) is the assumed threshold for new diversions, the annual potential diversions would be greater than 1 MAF in the majority of years. As the diversion flow threshold increases from 5,000 cfs to 20,000 cfs, the annual new diversion opportunity declines. These annual new diversion opportunities would be limited to the new storage capacity. The additional managed water supply that can be obtained with a new offstream storage reservoir located in the Sacramento River basin can be used to augment Delta exports and increase Delta outflow under each of the CALFED alternatives.

The releases from the new storage facility to augment Delta exports during years with delivery deficits or for increased Delta outflows during periods of relatively low outflow will govern the storage operations of the new storage facility.

Shasta and Clair Engle storage could be shifted (transferred) to the new storage facility to increase the flood control capacity and the refill potential for these reservoirs; however, this has not been simulated in the DWRSIM model.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Sacramento River water management may change because Alternative 1 will rely on reservoir reoperation to increase Delta water supply during periods of delivery deficits. There are also potential opportunities for increasing diversions to a new CALFED storage facility or of changing the monthly patterns of release from Shasta Reservoir if the TCD operation is effective for preserving more cold water in storage through the summer period; however, these potential changes in the monthly flow pattern and the seasonal reservoir operations have not been simulated with DWRSIM. Therefore, the only changes in Sacramento River operations being evaluated for the CALFED Programmatic EIR/EIS are diversions and releases for a new storage facility.

There are also potential changes from different Trinity River water management allocation and monthly exports patterns; however, these potential Trinity River changes have not been simulated with DWRSIM.

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The potential changes in Sacramento River water management under Alternative 2 are the same as those described under Alternative 1 if a new storage reservoir is constructed; however, none of these possible interactions with Trinity River exports and Shasta Reservoir operations have been simulated with the DWRSIM model.

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

The potential changes in Sacramento River water management under Alternative 3 are the same as those described under Alternatives 1 and 2 if a new storage reservoir is constructed; however, none of these possible interactions with Trinity exports and Shasta Reservoir operations have been simulated with the DWRSIM model.

FEATHER RIVER WATER SUPPLY AND WATER MANAGEMENT

OVERVIEW

The Feather River, with a watershed area of about 3,600 square miles above the Yuba River, is the largest tributary of the Sacramento River (Figure 30). Oroville Reservoir, the major storage facility of SWP, is operated by DWR. The Thermalito Diversion Dam, located about 5 miles downstream of Oroville Dam, is the upstream limit of anadromous fish. The Yuba River is the major tributary of the Feather River, with an additional watershed of 1,350 square miles that joins about halfway between Oroville and the mouth of the Feather River near Verona. There are several upstream reservoirs on the Feather River that contribute to the seasonal management of flows for irrigation diversions and releases for downstream uses. Oroville Reservoir has a storage capacity of about 3.5 MAF, and releases are made to the Feather River "low-flow" section below the Thermalito Diversion Dam and to the Thermalito forebay and afterbay complex, located about 5 miles downstream from Oroville Dam. Thermalito acts as a regulating reservoir for peaking power (including pump-back hydropower operations). Water is diverted from Thermalito afterbay to several major irrigation canals and released to the Feather River. The Oroville-Thermalito complex was completed in 1968.

WATERSHED RUNOFF CHARACTERISTICS

The Feather River contributes a substantial amount of high-quality water to the Sacramento River. Originating in the volcanic formations of the Sierra Nevada, the Feather River flows southwest to Lake Oroville and is joined by two major tributaries: the Yuba and Bear Rivers. The Yuba River joins the Feather River at the city of Marysville; the confluence with the Bear River is approximately 15 miles downstream of Marysville (Figure 30).

Figure 31 gives the monthly exceedance flows for inflow to Lake Oroville. The average flow of the Feather River at Oroville is about 5,800 cfs. The monthly flows indicate that both rainfall and snowmelt contribute to the natural runoff that is greater than 2,000 cfs (80% exceedance) from January through June. The summer flows are well sustained at about 1,000 cfs (80% exceedance) because of snowmelt and groundwater (i.e., springs) from the high-elevation watersheds. Upstream reservoirs (Lake Almanor) contribute some seasonal storage that reduces runoff in spring and increases flows in summer and fall. The average annual inflow to Oroville is simulated to be about 4.0 MAF, slightly less than the unimpaired inflow of 4.3 MAF because of several small upstream diversions.

The Yuba River drains a watershed of about 1,350 square miles of the western slope of the Sierra Nevada Mountains and is the major tributary to the Feather River. The average annual unimpaired flow is about 2.25 MAF. Several reservoirs have been constructed within the watershed.

Englebright Dam is the lowermost dam and blocked upstream anadromous fish migration when it was completed in 1941. The major storage reservoir is New Bullards Bar on the North Fork, with a storage capacity of about 1 MAF and a watershed area of 490 square miles. There are more than 15 other reservoirs with a combined storage capacity of 400 TAF. A major portion of the Yuba watershed, however, is unregulated and very high flows are released from Englebright during major storms. The Bear River is almost completely regulated and diverted for uses, except during very wet years. The average annual unimpaired inflow is about 300 TAF.

WATER MANAGEMENT FACILITIES

Lake Oroville has a storage capacity of approximately 3.5 MAF. Completed in 1968, the lake functions as the major storage facility for SWP. The Hyatt Powerhouse intake is at an elevation of 615 feet; the 13 TCPs can raise the sill elevation in 19-foot increments, from a minimum elevation of approximately 615 feet to a maximum elevation of approximately 860 feet. These are operated to reserve cool water for later in summer. Panels are raised to lower the effective elevation of the powerhouse outlet and lower the release temperature.

From Lake Oroville, the river flows south to the Thermalito Diversion Pool (16 TAF volume), where it can be pumped back into Lake Oroville, released down the Feather River, or diverted to the Thermalito forebay (10 TAF volume) and afterbay (71 TAF volume) reservoirs. A pumpback powerhouse connects these two storage pools. Releases to the Feather River below the diversion pool are regulated by instream flow requirements. The Feather River hatchery is located below the diversion pool. Most of the diverted water is returned to the Feather River downstream through Thermalito afterbay releases, while some water is diverted from the Thermalito afterbay to various canals.

RESERVOIR STORAGE OPERATIONS

Figure 32 shows the monthly distribution of historical Oroville storage for 1972-1992. Highest storage is achieved in the early summer months following spring runoff from snowmelt. The average annual change in storage has been approximately 1 MAF, with an average carryover storage of 2.2 MAF. Carryover storage was less than 1 MAF in 1977 and 1990. Because extremely low reservoir storage in late summer and fall may have a large effect on release temperatures, both the California Department of Fish and Game (DFG) and Anadromous Fish Restoration Program (AFRP) suggest a minimum carryover storage of 1.5 MAF.

Regulated Flows and Diversions

Substantial irrigation diversions from Thermalito afterbay were historically diverted from the Feather River in the vicinity of Oroville. These diversions now occur from the Thermalito complex. Figure 33 shows the exceedance values for diversions from Thermalito for 1971-1991. The maximum monthly diversions of about 2,500 cfs (150 TAF) are made in the May-August irrigation season. The total annual Thermalito diversions are slightly less than 1 MAF.

Releases of 600 cfs are made year round into the "low-flow" section of the Feather River, providing ideal holding, spawning, and rearing habitat for spring-run and fall-run salmon and steelhead. Releases from Thermalito afterbay to the Feather River are generally much warmer than releases from Oroville directly into the 8-mile-long "low-flow" section. Current streamflow requirements are 1,700 cfs below Thermalito from October to March and 1,000 cfs from April to September (some reductions allowed in dry years). A maximum of 2,500 cfs are maintained in October and November to prevent spawning in overbank areas that might become dewatered.

Figure 34 shows monthly historical exceedance flows near Gridley and indicates the combined effects of seasonal storage in Oroville and upstream reservoirs and irrigation diversions from Thermalito. The average historical flow is about 4,400 cfs, suggesting that an average of about 1,400 cfs are diverted or evaporated upstream of Gridley (compared with unimpaired flow).

The major diversions from the Yuba River are made at or near Daguerre Dam by six water districts from three diversions. There are several small unscreened diversions downstream of Daguerre. Although an average of about 600 cfs is diverted (a maximum of 1,000 cfs during summer months), the summer through fall flows at Marysville (July-October) are generally higher than unimpaired summer flows. The annual average diversions from the Yuba River are about 500 TAF. There are minimum flows below Engelbright Reservoir, but there are no required flows below Daguerre Dam or at Marysville.

Flows in the Bear River watershed are almost totally regulated by several storage and diversion facilities. Required fish releases downstream from Camp Far West storage reservoir and SSID diversion dam into Bear River are 25 cfs from April to June and 10 cfs the remainder of the year.

Historical Water Management Allocation

The historical water allocation for the Feather River has satisfied instream flow requirements at Gridley, as well as supplied diversions for water supply at Thermalito and along the Feather River. Additional releases from Oroville have been made to satisfy Delta outflow requirements and provide water for SWP exports at the Banks Pumping Plant.

Historical diversions from Thermalito have been measured with an average annual diversion of about 800 TAF (for 1969-1991). Many smaller diversions along the Feather River have not been measured. The flow requirements at Gridley can be approximated as ranging from 600 TAF in dry years to about 1 MAF in wet years; therefore, the allocation of Feather River runoff for instream flow and measured water supply diversion uses can be calculated to range from about 1.1 MAF to about 1.9 MAF. The historical annual summary of these water allocations is provided in Table 7.

The monthly historical water allocation pattern for the Feather River illustrates the use of large reservoir storage for managing the natural variations in the hydrology (i.e., runoff). Runoff is allocated to three general water management purposes: instream flows, diversions, or reservoir storage (for later beneficial use). When monthly runoff exceeds the monthly requirements for instream flow and export, the excess inflow is stored in the reservoir (if storage space is available) for subsequent use. Excess runoff must be released downstream (where the excess flows may provide instream flow benefits or be diverted and exported in the Delta). When the runoff is less than the monthly requirements for instream flow and diversions, Lake Oroville Reservoir storage is reduced to supply the necessary water.

Figure 35 shows the 1982-1991 period of monthly historical inflow, Lake Oroville Reservoir storage, and Lake Oroville storage releases compared with instream flow requirements and Thermalito diversions (i.e., total uses). The maximum monthly storage for flood control purposes is shown to indicate the available storage space in Lake Oroville Reservoir. Excess runoff occurs frequently because the available storage in Lake Oroville is relatively small relative to the runoff. When downstream uses are greater than inflow, Lake Oroville storage releases are used to supply downstream beneficial uses. When Oroville flows are greater than downstream uses, some of the inflow is stored in Lake Oroville (if storage space is available).

Table 7 gives the annual historical water management allocation values for the Feather River. The average Oroville inflow for 1969 to 1991 was about 4.3 MAF. An additional 2 MAF of runoff originates from the Yuba and Bear Rivers. The average Oroville carryover storage was 2.3 MAF. The average annual storage diversion was 1 MAF (about 25% of the Oroville inflow). The average annual storage release was also about 1 MAF, of which an average of about 250 TAF were carryover storage releases and the remaining 750 TAF were seasonal storage releases. Because the historical diversions and instream flow requirements are uncertain, estimating the fraction of runoff that was used for beneficial uses is difficult for the historical conditions. An average of 40% of the Oroville inflow is used for beneficial uses. Additional diversions and Delta outflow requirements are satisfied with Feather River flows downstream of the Yuba River.

NO-ACTION WATER MANAGEMENT ALLOCATION

Table 8 indicates that total annual simulated No-Action diversions on the Feather River averaged 2.5 MAF, with about 1 MAF from Thermalito and therefore about 1.5 MAF below the Yuba River. The DWRSIM diversions downstream of Thermalito apparently represent Yuba and Bear diversions (although these cannot be supplied with Feather River water), as well as irrigation diversions from the lower Feather River. The 1.5 MAF simulated diversions are much larger than the historical Yuba River diversions of about 500 TAF, suggesting that 1 MAF of diversions occur along the Feather River downstream of Thermalito.

The average simulated No-Action Alternative instream flow allocation at Gridley was about 850 TAF. When these two beneficial uses are combined, the total annual Feather River uses range from 2.5 MAF to about 3.7 MAF, with an average total use of 3.3 MAF. The fraction of Oroville inflow that is simulated for beneficial uses averages about 45% and ranges from about 20% in wet years to more than 100% in several dry years. The fraction of total runoff (including Yuba and Bear Rivers) that is simulated for beneficial uses averages about 50% and ranges from less than 20% in wet years to more than 100% in several dry years.

The No-Action simulation results indicate that an average of 1.1 MAF of the Oroville inflow is stored and later released for beneficial uses. The simulated carryover storage sequence indicates that an average of about 395 TAF of carryover storage are used to augment water supply in dry years. The remaining 700 TAF are used for seasonal storage and releases. The direct uses of runoff for instream flow and diversions in the Feather River basin above the Yuba averages 1.6 MAF. About 240 TAF of uses are supplied by reservoir releases. The remaining 750 TAF of releases must be for downstream uses along the Feather River or in the Delta. Oroville releases are required for about 15% of the uses upstream of the Yuba River and about 26% of the simulated total uses.

Figure 36 shows the simulated No-Action monthly water allocation for the Feather River for 1982-1991. The Feather River runoff and Oroville releases are compared with the total uses (instream flows and diversions). The inflows are often greater than beneficial uses in winter months; however, during summer months, storage releases are needed to supply beneficial uses along the Feather River and downstream in the Delta. The portion of the storage releases that are used in the Delta can be estimated in months when the total water supply (i.e., runoff and storage releases) is greater than the total Feather River uses.

Figure 37 shows the simulated monthly No-Action Alternative Feather River diversions from Thermalito and along the Feather, Yuba, and Bear Rivers. The maximum monthly diversions are greater than 5,000 cfs (300 TAF) from April through August.

Figure 38 shows the distribution of monthly simulated flows at Gridley for the No-Action Alternative. The maximum monthly instream flow requirements at Gridley are shown for reference. Some of the summer simulated flows are less than the historical flows at Gridley.

Figure 39 shows the distribution of monthly simulated flows at the mouth of the Feather River for the No-Action Alternative. The flows from the Yuba and Bear Rivers sometimes increase the flows at Gridley, although there are substantial irrigation diversions simulated downstream of Gridley as well.

Figure 40 summarizes the annual Feather River water allocation as simulated for the No-Action Alternative upstream of the Yuba River. The available water is usually more than the combined uses for instream flow and diversions. Some fraction of this excess water is used in the

Delta and the remainder contributes the surplus Delta outflow, which may provide additional ecological benefits in the estuary and Bay.

Figure 41 shows that the No-Action simulation of Lake Oroville carryover storage sequence is similar but not identical to the historical carryover storage sequence. Both diversions along the Feather River, Delta exports, and Delta outflow requirements have substantially increased from the historical conditions, modifying the necessary Oroville storage operations.

Figure 42 shows the No-Action simulation of annual Thermalito diversions compared with the historical Thermalito diversions. The historical Thermalito diversions are a little less than the simulated diversions upstream of the Yuba River because there are several additional diversions along the Feather River.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Feather River water management may change because Alternative 1 will rely on reservoir reoperation to increase Delta water supply during periods of delivery deficits. Because Oroville Reservoir is the major upstream SWP storage facility, Oroville operations may change if Delta pumping is modified by increased permitted Delta pumping capacity or the addition of new aqueduct storage. There are also potential opportunities for increasing diversions to a new CALFED storage facility. Instream flows at Gridley may be modified to achieve additional fisheries benefits; however, these potential changes in the monthly flow pattern and the seasonal reservoir operations have not been specifically simulated with modified operational rules in the DWRSIM model. Some changes in Oroville operations and Gridley flows are simulated as a result of increased Delta exports with additional aqueduct storage and increased maximum pumping capacity (DWRSIM 472B and 510).

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The expected changes in Feather River operations under Alternative 2 are similar to those under Alternative 1.

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

Some additional changes in Feather River operations are expected with Alternative 3 because the isolated conveyance facility may allow export pumping patterns to shift and may also allow Delta standards to be modified (i.e., export/inflow ratio objectives may be relaxed). The DWRSIM model results are slightly different with an isolated facility, but the possible relaxation of the export/inflow ratio has not been included in the DWRSIM model assumptions.

AMERICAN RIVER WATER SUPPLY AND WATER MANAGEMENT

OVERVIEW

The American River drains a watershed of about 1,900 square miles, with an average runoff of about 2.6 MAF. Folsom Lake is the largest reservoir on the American River, with a storage capacity of about 1 MAF. There are several upstream reservoirs, with a total storage capacity of about 1 MAF. Nimbus Dam, a regulating reservoir constructed about 23 miles upstream of the American River mouth, is the upstream migration barrier for salmon and steelhead and provides diversions to the Folsom South Canal. Historical diversions along the American River are estimated to be about 400 TAF and the majority of Folsom Reservoir storage releases are used for Delta exports and Delta outflow requirements.

WATERSHED RUNOFF CHARACTERISTICS

The American River is a major tributary of the Sacramento River, entering just north of Sacramento. The American River drains a watershed of about 1,900 square miles that covers the western Sierra Nevada Mountains and foothills with three major branches: the South Fork, Middle Fork, and North Fork. Maximum elevations are about 10,000 feet and a substantial portion of the runoff results from snowmelt. Figure 43 shows a map of the American River watershed.

Figure 44 shows the monthly exceedance inflows, which are modified from the unimpaired flows by several upstream reservoirs and diversions. During low-runoff years (70% exceedance), the historical inflows are almost uniform, with monthly flows of about 100-200 TAF throughout the year.

WATER MANAGEMENT FACILITIES

Development began during the Gold Rush with numerous diversions and small impoundments. There are now 13 major reservoirs with a total storage capacity of about 2 MAF. Folsom Lake was constructed in 1956 and is the largest reservoir on the American River with a storage capacity of about 1 MAF. Nimbus Dam, a regulating reservoir constructed downstream of Folsom Dam and about 23 miles upstream of the mouth, is the upstream migration barrier for salmon and steelhead and provides diversions to the Folsom South Canal. The Nimbus hatchery, located just below Nimbus Dam, was constructed as mitigation for the effects of Folsom and Nimbus Dams that eliminated upstream salmon and steelhead spawning and rearing habitat.

Diversions are made from Folsom Lake, from the Folsom South Canal, and from the lower American River (Carmichael and Sacramento City water treatment plants). Measurements of these historical diversions are not available. Based on the No-Action Alternative (with current hydrology and demands), the diversions from Folsom Reservoir are about 210 TAF. Annual diversions from Folsom South Canal are about 70 TAF and lower American River diversions are about 120 TAF. Total American River diversions are therefore about 400 TAF but are expected to increase in the future.

RESERVOIR STORAGE OPERATIONS

Figure 45 shows the monthly exceedance storage for 1962-1992. Folsom Lake storage capacity is approximately 975 TAF and the normal annual drawdown is approximately 500 TAF. The required flood control storage is dependent on upstream storage. Additional flood control space has been provided in recent years to increase flood protection along the American River.

REGULATED FLOWS AND DIVERSIONS

Because releases from Folsom are made in summer to supply CVP exports from the Delta and maintain sufficient Delta outflow to satisfy water quality objectives, summer and fall streamflows in the Lower American River are much higher inflows or unimpaired flows would have been. Because diversions are primarily located downstream, the Lower American River is used as the natural conveyance for the majority of Folsom releases. The average historical flow is about the same as the average unimpaired flow.

Figure 46 was to have shown the estimated monthly diversions for the American River but historical diversion data could not be found. The seasonal pattern is governed by the municipal water supply uses along the American River. The two largest diversions are the San Juan Water District located in Folsom Reservoir and the City of Sacramento Fairbairn treatment plant located about 7 miles upstream of the mouth of the American River. Because historical measurements could not be found, these monthly diversions are estimated from the simulated No-Action Alternative DWRSIM results for the American River.

Instream flow requirements were established in the State Water Resources Control Board (SWRCB) Decision 893; 500 cfs during the fall spawning season (Sept 15 through Dec 15), with 250 cfs for the remainder of the year (annual allocation of about 225 TAF). Only during extreme droughts have American River flows been this low. DFG has determined that these flows are insufficient to maintain anadromous fishery resources in good condition. SWRCB Decision 1400, following hearings from the proposed Auburn Dam, specified higher releases from Nimbus should the Auburn Dam be constructed. D-1400 flows are 1,250 from October 15 to July 15, with 800 cfs for the remainder of the year (annual allocation of about 825 TAF). A 1990 court order (Hodge Decision) specified American River streamflow conditions that must be satisfied before allowing the East Bay Municipal Utility District (EBMUD) to divert any water from the Folsom South Canal (Folsom South canal diverts water from Nimbus Dam). The court-required flows for EBMUD diversions are 2,000 cfs from October 15 through February 28, 3,000 cfs from March 1 through June 30, and 1,750 cfs between July 1 and October 14.

Current operations use a relationship between storage and projected inflow to determine instream flow requirements. At relatively high storage and projected inflow values, instream flow requirements are set at the maximum AFRP monthly targets. As storage and projected inflow decreases, the instream flow requirements are reduced. This provides an adaptive balance between available water and instream flow benefits. The maximum specified instream flows are 2,500 cfs for July through February, with 4,500 specified from March through June. The maximum instream flow use is therefore about 2.3 MAF; however, the average instream flow allocation is about 1.5 MAF.

Figure 47 shows the historical monthly exceedance flows downstream of Nimbus. The summer flows are much higher than inflows or unimpaired flows because reservoir releases are being made to supply downstream uses for instream flow and Delta exports and Delta outflow.

HISTORICAL WATER MANAGEMENT ALLOCATION

The historical water allocation for the American River has satisfied instream flow requirements at Nimbus, as well as supplied diversions for water supply from Folsom Reservoir, Folsom South Canal, and along the American River. Additional releases from Folsom have been made to satisfy Delta outflow requirements and provide water for CVP exports at the Tracy Pumping Plant.

Table 9 gives the annual historical water management allocation values for the American River. The average Folsom inflow for 1957 to 1993 was about 2.6 MAF. The average Folsom carryover storage was 560 TAF. The average annual storage increase was 460 TAF (about 18% of the Folsom inflow). The average annual storage release was also about 460 TAF, of which an average of about 80 TAF were carryover storage releases and the remaining 380 TAF were seasonal storage releases. Because the historical diversions and instream flow requirements are uncertain, estimating the fraction of runoff that was used for beneficial uses is difficult for the historical conditions. An average of about 20% of the Folsom inflow was used for historical beneficial uses. Almost all of the American River diversions and instream flow requirements have been satisfied without requiring Folsom Reservoir releases. Additional diversions and Delta outflow requirements are satisfied with American River flows and releases from Folsom storage.

Historical diversions from the American River are assumed to be approximately 400 TAF. The flow requirements at Nimbus have been relatively small, ranging from 225 TAF to 825 TAF;

therefore, the allocation of American River runoff for instream flow and estimated water supply diversion uses can be calculated to range from about 625 TAF to about 1.2 MAF.

Figure 48 shows the monthly historical inflow for 1982-1991, Folsom Reservoir storage, Folsom storage release, estimated diversions, and instream flows. The maximum monthly storage for flood control purposes is shown to indicate the available storage space in Folsom Reservoir. Excess runoff occurs frequently because the available storage in Folsom is small relative to the runoff. When downstream uses are greater than inflow, Folsom storage releases are made to supply downstream beneficial uses. When Folsom inflows are greater than downstream uses, some of the inflow is stored in Folsom Lake. Often, however, the inflow cannot be stored because of the limited storage space during the flood control season.

NO-ACTION WATER MANAGEMENT ALLOCATION

Table 10 indicates that total average annual simulated No-Action Alternative inflows for 1922-1994 were 2.6 MAF. Simulated diversions on the American River averaged 400 TAF. Instream flow requirements ranged from less than 500 TAF in very dry years to a maximum of 2.3 MAF, with an average of 1.5 MAF.

The fraction of Folsom inflow that is simulated for beneficial uses averages about 70% and ranges from about 40% in wet years to more than 100% in several dry years. The No-Action simulation results indicate that an average of 470 TAF of the Folsom inflow are stored and later released for beneficial uses. The simulated carryover storage sequence indicates that an average of about 100 TAF of carryover storage are used to augment water supply in dry years. The remaining 370 TAF are used for seasonal storage and releases. The direct uses of runoff for instream flow and diversions in the American River basin averages 1.5 MAF. About 300 TAF for uses are supplied by reservoir releases. The remaining 170 TAF of releases must be used for downstream uses in the Delta.

Figure 49 shows the simulated No-Action monthly water allocation for the American River for 1982-1991. The Folsom inflow and storage releases are compared with the total uses (instream flows and diversions). The inflows are usually greater than beneficial uses; however, during summer months, storage releases are needed to supply beneficial uses along the American River and downstream in the Delta. The portion of the storage releases that are used in the Delta can be estimated in the months when the total water supply (i.e., runoff and storage releases) is greater than the total American River uses.

Figure 50 shows the simulated monthly No-Action Alternative American River diversions. The maximum monthly diversions are about 60 TAF (1,000 cfs) in July.

Figure 51 shows the distribution of monthly simulated flows at Nimbus for the No-Action Alternative. The maximum monthly instream flow requirements at Nimbus are shown for reference. The maximum specified instream flows are satisfied in about 30% of the years.

Figure 52 summarizes the annual American River water allocation as simulated for the No-Action Alternative. The available water is usually more than the combined uses for instream flow and diversions. Some fraction of this excess water is used in the Delta, and the remainder contributes the surplus Delta outflow, which may provide additional ecological benefits in the estuary and Bay.

Figure 53 shows that the No-Action simulation of Folsom carryover storage sequence is similar but not identical to the historical carryover storage sequence. Instream flow requirements, Delta exports, and Delta outflow requirements have substantially increased from the historical conditions, modifying the necessary Folsom storage operations and producing lower simulated No-Action Alternative carryover storage in several years.

Figure 54 shows the No-Action simulation of annual American River diversions. The historical diversions are assumed to be similar. Delivery deficits were simulated in only a few very dry years.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

American River water management may change because Alternative 1 would rely on reservoir reoperation to increase Delta water supply during periods of delivery deficits. Because Folsom Reservoir is the major upstream CVP storage facility, Folsom operations may change if the Delta pumping is modified by increased permitted Delta pumping capacity or the addition of new aqueduct storage. There are also potential opportunities for increasing diversions to a new CALFED storage facility located in the American River watershed (i.e., Auburn Dam). Diversions may increase in the future on the American River. Instream flows at Nimbus may be further modified to achieve additional fisheries benefits, although the adaptive management based on available water is already assumed implemented for the No-Action Alternative; however, these potential changes in the monthly flow pattern and the seasonal reservoir operations have not been specifically simulated with modified operational rules in the DWRSIM model. Auburn has not been simulated with DWRSIM. Some changes in Folsom operations and Nimbus flows are simulated as a result of increased Delta exports with additional aqueduct storage and increased maximum pumping capacity (DWRSIM 472B and 510).

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The expected changes in American River operations for Alternative 2 are similar to those for Alternative 1.

Alternative 3 Water Management Allocation

Some additional changes in American River operations are expected under Alternative 3 because the isolated conveyance facility may allow export pumping patterns to shift and may also allow Delta standards to be modified (i.e., export/inflow ratio objectives may be relaxed). The DWRSIM model results are slightly different with an isolated facility (DWRSIM 475 and 500), but the possible relaxation of the export/inflow ratio has not been included in the DWRSIM model assumptions.

Other Central Valley Tributary Basins

There are several tributaries with reservoir storage and diversions that are not specifically included in the DWRSIM model. The water management operations on the Yuba and Bear Rivers are not simulated, but the net outflows from these basins has been simulated as part of the hydrology inputs (inflows and diversions) for the DWRSIM model. These tributaries are discussed briefly in the Feather River water management assessment.

Cache Creek (Clear Lake) and Putah Creek (Lake Berryessa) are not simulated but the net flows from these tributaries are included in the DWRSIM model as part of the Yolo basin hydrology.

The Cosumnes, Mokelumne, and Calaveras Rivers are tributaries of the San Joaquin River that are not specifically simulated in the DWRSIM model. These streams are referred to as the eastside streams in Delta inflow evaluations. The Cosumnes River does not have a major storage facility although several agricultural diversions are located along the lower river. The Mokelumne is highly regulated by two major reservoirs operated by the EBMUD. Pardee Reservoir supplies the Mokelumne Aqueduct, and Comanche Reservoir provides flood control and water supply benefits for downstream users. The Calaveras River has a reservoir that almost totally regulates flows for downstream irrigation diversions.

Delta Water Supply and Water Management

Overview

Water management in the Delta is similar to water management in the tributary basins. The available monthly inflows from the tributary basins are allocated to 1) supply in-Delta diversions for agricultural and municipal water supply demands, 2) provide minimum Delta outflow required to satisfy 1995 WQCP objectives, and 3) allow Delta exports within the 1995 WQCP export/inflow ratio and the permitted pumping capacity. Some of the exports are used for direct deliveries to satisfy water supply demands and some of the exports are stored in San Luis Reservoir (or other local water storage facilities) for later delivery. Any water that cannot be used for one of these beneficial uses is considered to be surplus (i.e., unallocated) Delta outflow, although there may be increased ecological values associated with these higher Delta outflows.

WATERSHED RUNOFF CHARACTERISTICS

The Delta inflows originate from the Sacramento River (including Yolo Bypass), the San Joaquin River at Vernalis, the eastside streams, and local runoff from precipitation (Figure 55) The historical average annual Delta inflow for 1967-1991 was about 25 MAF. The difference between unimpaired and historical inflow represents the upstream water management activities in the tributary basins. The historical monthly Delta inflows vary substantially from regulated periods of relatively low flow (e.g., 10,000 cfs) to periods of extremely high inflow (e.g., greater than 100,000 cfs). The monthly historical Delta inflows are slightly higher than unimpaired inflows during some dry periods.

The monthly historical Delta inflow exceedance values for 1972-1992 are shown in Figure 56. The highest historical Delta inflows occur from January through April, corresponding to the rainfall and flood control season when reservoir storage diversions are limited. The historical inflows are generally higher than the unimpaired inflows from July through October because reservoir releases are being made to supply Delta outflow requirements and export demands.

The Sacramento River maximum channel flow capacity is approximately 80,000 cfs. Sacramento River flows greater than this capacity are diverted into the Yolo Bypass upstream of Sacramento. During late summer of most years, the minimum Sacramento River flows at Freeport are approximately 10,000 cfs. Maintaining salinity control with Delta outflow is most critical during these low-flow periods. During periods of high runoff, a large proportion of Sacramento River and Yolo Bypass flows cannot be controlled by upstream reservoirs. Regardless of CVP and SWP reservoir operations, the high runoff flows enter the Delta in response to natural hydrologic conditions.

San Joaquin River flows have frequently been less than 1,000 cfs. In recent years, releases from New Melones Reservoir have been used to maintain San Joaquin River flows for salinity control. Most runoff occurs during winter storms, when maximum flows on the San Joaquin River can exceed 20,000 cfs and flows of the combined eastside streams can exceed 10,000 cfs. High flows in the other eastside streams and the Sacramento River generally correspond to periods of high flow in the San Joaquin River.

Table 11 gives the annual historical Delta inflow for 1967-1991. The average annual inflow from the Sacramento River (including Yolo Bypass) for 1967-1991 was about 20.5 MAF. The average annual flow in the San Joaquin River for 1967-1991 was about 3.5 MAF. The combined average flow in the eastside streams (Mokelumne, Cosumnes, and Calaveras Rivers) for the same period was approximately 1.1 MAF. Rainfall in the Delta is not considered as Delta inflow because a large fraction is assumed to be stored in the Delta soils.

WATER MANAGEMENT FACILITIES

Several important water management facilities are located in the Delta (Figure 56). These include the Contra Costa Pumping Plants at Rock Slough and Old River, CVP Pumping Plant at Tracy, Delta Cross Channel (DCC) at Walnut Grove, SWP Clifton Court Forebay and Banks Pumping Plant, North Bay Aqueduct Pumping Plant, and Suisun Marsh Salinity Control Structure on Montezuma Slough.

The CVP Tracy Pumping Plant has a maximum pumping capacity of approximately 4,600 cfs, the nominal capacity of the Delta-Mendota Canal at the pumping plant. Although seasonal fluctuations occur in CVP water demands, additional export pumping is used to fill the CVP portion of San Luis Reservoir. CVP facilities also include DCC and the Contra Costa Canal. DCC is a gated diversion channel in the Sacramento River near Walnut Grove. When DCC gates are open, Sacramento River water can be diverted through natural channels of the lower Mokelumne and San Joaquin Rivers toward the CVP and SWP pumping plants in the southern Delta.

The Contra Costa Canal originates at Rock Slough, which connects with Old River, approximately 4 miles southeast of Oakley. Diversions have historically ranged from 50 to 250 cfs at the unscreened Rock Slough facility (Contra Costa Canal Pumping Plant Number 1). Although the canal and its associated facilities are part of CVP, they are operated and maintained by the Contra Costa Water District (CCWD). CCWD is presently constructing a second pumping plant on Old River and the new Los Vaqueros Reservoir that will allow emergency storage and water quality storage. Los Vaqueros will be refilled by diversions only when chloride concentration is less than 65 milligrams per liter (mg/l). Los Vaqueros water will be used for delivery during low Delta outflow periods when chloride concentration at Rock Slough and Old River is greater than 65 mg/l.

The SWP Banks Pumping Plant supplies water for the South Bay Aqueduct and the California Aqueduct, with an installed pumping capacity of 10,300 cfs. The Banks Pumping Plant is presently limited by a U.S. Army Corps of Engineers (Corps) permit with a maximum permitted capacity of 6,680 cfs plus 33% of the San Joaquin River flow (if greater than 1,000 cfs) between December 15 and March 15. An additional four pumps became operational in 1992, increasing the maximum Banks Pumping Plant capacity to approximately 10,300 cfs. The Interim South Delta Program (ISDP) would improve south Delta channels to allow use of the full Banks Pumping Plant capacity whenever Delta inflows are sufficient to satisfy the 1995 WQCP objectives for outflow and maximum percent of inflow that can be exported (i.e., 35% of inflow during February-June, 65% of inflow in remaining months).

Other DWR facilities around the Delta include the North Bay Aqueduct, the Suisun Marsh Salinity Control Structure, and several temporary barriers in the south Delta. SWP pumps water from Barker Slough into the North Bay Aqueduct for use in Napa and Solano Counties. Maximum pumping capacity at Barker Slough is 175 cfs (pipeline capacity); the average annual pumping rate is approximately 35 cfs.

The Suisun Marsh Salinity Control Structure spans Montezuma Slough near Collinsville. The structure's primary objective is to meet the water quality criteria in Suisun Marsh that were developed to offset the effects of upstream diversions by CVP, SWP, and other water diversions. When operating, the salinity control tidal gate structure is opened to allow full tidal flow from the Sacramento River near Collinsville into Suisun Marsh channels during ebb tides. Floodtide flow from Suisun Marsh is blocked by the gates. This tidal gate operation scheme produces a net flow of approximately 2,000 cfs into Montezuma Slough from the Sacramento River at Collinsville.

REGULATED FLOWS AND DIVERSIONS

The historical in-Delta diversions are estimated in the DWR water budget for the Delta (i.e., DAYFLOW database). CCWD pumping, North Bay Aqueduct pumping, and Vallejo pumping are considered to be in-Delta diversions. The estimated historical in-Delta diversions have increased with higher demands in the service areas and changing Delta agricultural land use; however, the estimated current level of demands is approximately 1.75 MAF.

The historical Delta outflow requirements (minimum Delta outflow) for the historical record is sometimes difficult to estimate because of changing regulatory requirements. The historical estimates assuming D-1485 requirements (as simulated by DWRSIM) given in Table 11 are therefore only approximate. The annual outflow requirements range from 3 MAF to over 6 MAF, with an average of about 5 MAF.

The annual historical exports (combined CVP Tracy and SWP Banks) given in Table 11 increased during the 1967-1991 period and reached an approximate maximum of 6 MAF in the late 1980s. The average annual CVP and SWP exports during 1967-1991 were about 4 MAF. The SWP Banks Pumping Plant began operating in 1968, but San Luis Reservoir was first filled in 1969 and the Edmonton Pumping Plant (delivering water to southern California) was not completed until 1973.

The exceedance values of monthly historical combined CVP and SWP exports for 1972-1992 are shown in Figure 57. The reduced pumping in May and June reflects the D-1485 export limits during these months. Some of the exports were delivered directly and some of the exports were stored in San Luis Reservoir or local water storage facilities for later delivery. The estimated historical maximum monthly demand pattern for Delta exports is shown for comparison (assumed a 7 MAF total demand).

The maximum physical pumping capacity for combined CVP and SWP is approximately 15,000 cfs. CALFED alternatives that include the ISDP or similar actions to allow full use of the installed pumping capacity will increase the flexibility for obtaining necessary exports to satisfy water supply demands while avoiding periods with greatest potential fisheries impacts from entrainment.

Figure 58 shows the monthly ratio of exports to inflow for 1972-1992. This is used as one of the 1995 WQCP objectives and may be a general indicator of entrainment effects. The historical maximum export/inflow ratio has been about 70% and the ratio has been less than 50% for about 80% of the months (20% exceedance).

RESERVOIR STORAGE OPERATIONS

The San Luis Reservoir provides an opportunity for storage of exports that are not immediately needed for water supply deliveries. Although the reservoir is operated as a joint-use facility by SWP and CVP, with each using approximately half of the 2 MAF storage capacity, the combined storage in San Luis will be used to illustrate the basic water management of Delta exports.

Figure 59 shows the historical monthly San Luis storage exceedance values for 1971-1991. The reservoir has been almost fully utilized for seasonal storage and release in many years. When San Luis is full, no excess Delta exports (i.e., beyond monthly demands) can be made, regardless of the Delta inflow available for pumping.

Additional storage south of the Delta would allow additional exports to be made during periods of high Delta inflow and later be used to supplement water supply deliveries or to reduce Delta exports in subsequent months when greater environmental impacts (i.e., higher fisheries entrainment or poor water quality) are anticipated. An in-Delta storage facility could serve as seasonal storage, much as San Luis Reservoir is now used; however, an in-Delta storage facility will also increase the effective diversion capacity during high-flow periods so that diversion opportunities may be increased. Releases from the in-Delta storage facility could be made to either increase Delta outflow or increase exports during periods when there is unused export pumping capacity. If the in-Delta storage is directly connected to the export pumps (with a siphon or channel), the stored water can be used without affecting Delta channel flows.

Figure 60 shows the monthly Delta outflow exceedance values for 1971-1991. The winter outflows are somewhat reduced from unimpaired values because of upstream reservoir storage diversions and Delta exports. The summer and fall outflows are often higher than unimpaired flows because of the specified minimum Delta outflow requirements.

Historical Water Management Allocation

The historical water management allocation for the Delta can be calculated and described in much the same way as was done for each tributary basin. The available inflow is compared with the specified minimum Delta outflow, in-Delta diversions, and Delta exports. Some of the Delta inflow is dependent on upstream reservoir storage releases. Some of this inflow has already provided instream flow benefits along the tributary streams.

Table 11 gives the annual summary of the historical water management allocation for the Delta for 1967-1991. The average annual inflow was 25 MAF and the historical average exports were 4 MAF. Historical in-Delta depletions were about 1.7 MAF. The annual average Delta outflow was about 20 MAF and the required Delta outflow was about 5 MAF (for historical D-1485 outflow requirements). The surplus (unallocated) Delta outflow during this period therefore averaged about 15 MAF.

Historical average annual exports were about 4 MAF. In 1967 the exports directly supplied the deliveries of 1.25 MAF. San Luis Reservoir allowed some of the exports to be stored and used during the irrigation season. The average diversion to San Luis Reservoir storage for the 1967-1991 period was about 870 TAF, supplying about 20% of the annual average deliveries of 4 MAF. San Luis Reservoir storage capacity therefore has allowed total deliveries to be increased by an average of about 25% (maximum 1.5 MAF storage release with a maximum total delivery of 6 MAF).

Figure 61 shows the historical monthly Delta water management allocation for 1982-1991. There are several months with more Delta inflow than required to satisfy the estimated minimum Delta outflow, supply the in-Delta diversions, and provide all needed export pumping (up to the permitted capacity). In these months, there is surplus Delta outflow. Surplus Delta outflow may provide substantial ecological benefits in the San Francisco Bay estuary, but these benefits are not estimated in the water supply impact assessment. One of the possible uses for additional water supply is to augment the required Delta outflow during low-flow periods. This new water supply might be developed by building upstream storage or by allowing increased pumping during high flows (i.e., full pumping capacity) and constructing additional aqueduct storage facilities.

No-Action Water Management Allocation

Figure 62 shows the simulated monthly No-Action Alternative Delta water management allocation for 1982-1991. In many months, all available Delta inflow is for Delta beneficial uses. There are, however, some months with more Delta inflow than required to satisfy the 1995 WQCP objectives for minimum Delta outflow (including X2 requirements), supply the in-Delta diversions, and provide all simulated export pumping (up to the allowable export ratio or permitted capacity) for approximately 7 MAF of annual demands.

Table 12 gives the annual summary values for the No-Action Alternative water management allocation for 1922-1994. The average simulated Delta inflow was about 22 MAF, with a range of less than 8 MAF (in 1977) to more than 68 MAF (in 1983). The required Delta outflow under the 1995 WQCP objectives averaged 5.5 MAF, with a range of less than 4 MAF to about 8 MAF. The simulated in-Delta net channel depletions were about 1.2 MAF. The total exports averaged 6.4 MAF, with a range of from less than 3 MAF to about 8 MAF.

Table 12 also gives the allocation of the exports between direct delivery and San Luis Reservoir storage. The average direct delivery of Delta exports was about 5 MAF and the annual average storage diversion (sum of monthly increases in San Luis Storage) was 1.3 MAF; therefore, the percentage of total delivery that depended on storage was about 20%. The annual storage diversions and releases are usually about the same, so the carryover storage in San Luis Reservoir remains relatively constant from year to year, with an average carryover storage of 630 TAF. Only in 8 years was the simulated carryover storage greater than 1 MAF (50% full) at the end of September. An average of only 135 TAF were used as carryover storage from one year to the next. The majority of San Luis storage was used for seasonal storage.

The simulated surplus Delta outflow was relatively large in many years, ranging from less than 100 TAF to more than 50 MAF, with an average of 8.7 MAF. The last column in Table 12 indicates that the average percentage of Delta inflow that was allocated for beneficial uses was 61%. The remaining 40% was surplus Delta outflow and could not be used for water supply purposes.

Figure 63 shows the monthly exceedance values for simulated No-Action export pumping. The months with moderately reduced pumping are April, May, and June because of the export limits during the April 15-May 15 San Joaquin River pulse flow and because the maximum allowable export of 35% of June inflow is often limiting. Nevertheless, export pumping is between 5,000 cfs and 10,000 cfs most of the time.

Figure 64 shows the monthly exceedance values for simulated No-Action Delta outflows. The minimum allowed Delta outflows (90% exceedance) under the 1995 WQCP are somewhat increased compared with the historical Delta outflows.

Figure 65 shows the annual No-Action water management allocation for the Delta. The variation in the available runoff represents the major challenge for CALFED water management in the Delta. Almost all of the water is already allocated for beneficial uses in several dry years. For example, there is less than 1 MAF of simulated surplus Delta outflow in 8 years. It will be extremely difficult to obtain additional water supply directly from the Delta in these years. Most of the remaining surplus Delta outflow occurs during months when the pumps are at the maximum permitted capacity or during periods when the maximum allowable export percentage of inflow pumping creates an equivalent outflow requirement that is greater than the minimum estimated outflow needed to satisfy the other 1995 WQCP objectives.

Figure 66 shows the simulated No-Action carryover storage in San Luis Reservoir compared with the historical carryover storage. San Luis is used primarily for seasonal storage, with very little carryover from year to year. The simulated No-Action storage pattern is similar to the historical San Luis carryover storage.

Figure 67 shows the simulated annual aqueduct deliveries for the No-Action Alternative. There are variations in annual deliveries during wet years because the SWP contractors are assumed to use some interruptible water in wet years beyond the fixed maximum demand. There are several years with delivery deficits caused by lack of available water for export. The average annual delivery for the No-Action Alternative was 6.1 MAF, with a range of about 2.3 MAF (in 1977) to about 8.1 MAF (in 1983).

DELTA EXPORT LIMITS

There are several factors that may limit Delta exports. These various limitations on Delta exports will have different effects on the potential future Delta water management under the CALFED alternatives, as briefly described below.

The first export limitation is the combined physical pumping capacity of the CVP and SWP pumping plants, which is now approximately equal to the combined physical conveyance capacity of the CVP Delta-Mendota Canal (4,600 cfs) and the California Aqueduct (10,200 cfs). The monthly maximum export rate is therefore about 15,000 cfs, with a monthly volume of about 900 TAF. None of the CALFED alternatives will increase this maximum physical export capacity.

The SWP pumping capacity is currently limited by a Corps permit as a daily average of about 6,680 cfs, except during periods of high (greater than 1,000 cfs) San Joaquin River inflow between December 15 and March 15, when the daily permitted capacity increases by one-third of the San Joaquin River flow. Each of the CALFED alternatives includes the possibility of modifying the Clifton Court intake and south Delta channels to allow the permitted SWP capacity to increase to the physical capacity.

Exports are limited under the 1995 WQCP to a specified fraction of the Delta inflow. The monthly fraction is 65% from July through January, and decreases to 35% from February through June. Exports may be limited by this Delta operational rule whenever inflows are less than that required to allow full capacity (or permitted) export pumping. Inflows could be increased by reservoir storage releases, but only a portion (export/inflow ratio) of the increased inflows could be used to increase Delta exports. Each of the CALFED alternatives could increase Delta inflows in some months to allow higher Delta exports, by reoperating existing storage or operating new storage facilities.

Exports may be limited by the minimum required Delta outflow whenever the Delta inflow is not sufficient to provide the required minimum outflow, supply the in-Delta water supply diversions, and allow full capacity (or permitted) export pumping. Delta inflow could be increased in these months to allow increased Delta exports. Whenever Delta outflow limits exports, any increased inflow can be exported until the full (or permitted) export capacity is reached. Each of the CALFED alternatives could increase Delta inflows in some months to allow higher Delta exports, by reoperating existing storage or operating new storage facilities.

The final possible limitation on Delta exports is a lack of aqueduct demands for water deliveries and/or a lack of reservoir storage space to store the exported water. Aqueduct demands (combination of CVP and SWP) are assumed to be approximately 7.5 MAF under each of the CALFED alternatives. Under the No-Action Alternative, San Luis Reservoir is the only simulated aqueduct storage facility. Under each of the CALFED alternatives, additional aqueduct storage facilities could be constructed to allow increased Delta exports in months with sufficient inflows that are now limited by the combination of aqueduct demands and storage capacity limitations.

The possibility for increased Delta exports under the current Delta outflow and export/inflow ratios can be estimated using the simulated No-Action Delta water management conditions. Without changing monthly Delta inflows or monthly required outflows, the simulated exports can be compared with the allowable fraction of inflow, the permitted pumping capacity, and the physical pumping capacity.

Table 13 provides the annual simulated No-Action Delta exports and estimates of additional exports that could be made if the permitted pumping capacity is maintained and if the full physical pumping allowed can be calculated. Both of these estimates of additional exports assume that the aqueduct storage capacity is increased to provide unlimited storage for these additional exports. The surplus Delta outflow and the additional outflow needed to provide a minimum flow of 12,000 cfs from January through June (i.e., 4.35 MAF total required) is also given because this has been used as a surrogate for potential use of additional water for environmental benefits. The annual average augmented outflow requirement would be about 500 TAF with a range from less than 100 TAF in 18 years (25% of the years) to more than 1 MAF in 14 years (20% of the years).

The permitted capacity is about 8 MAF (not including additional pumping allowed when San Joaquin River flows are high between December 15 and March 15). The average unused permitted capacity is 1.8 MAF, but an average of only about 300 TAF could have been exported in addition to that simulated for the No-Action Alternative. The remaining permitted capacity can only be used if additional Delta inflow is supplied from additional upstream storage facilities. If the permitted SWP pumping limits were increased to the physical pumping capacity, there would be an average of 4.2 MAF of unused pumping capacity. An average of 1.2 MAF of additional exports would be possible under the 1995 WQCP objectives. Additional aqueduct storage would be required to actually deliver this extra pumping because the exports would generally be in months when demands were already being satisfied.

Figure 68 shows the annual simulated No-Action Delta exports (combined CVP and SWP) and the potential additional exports for 1982-1991. There is very little unused permitted pumping capacity; the annual average additional exports using the permitted capacity is about 290 TAF, with a range of 0 to about 1 MAF (in 1984). If the full SWP pumping capacity is available, than an average of 1.2 MAF additional exports, with a range of 0 to about 3.0 MAF, could be made under the 1995 WQCP objectives.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Alternative 1 would maintain the existing Delta channels and export locations and would therefore maintain the existing 1995 WQCP Delta objectives. Under Alternative 1, however, it may be feasible to increase the permitted pumping capacity of the SWP Banks Pumping Plant to the physical capacity, with some modifications in the south Delta channels as described in the ISDP.

Under Alternative 1, there may also be new storage facilities constructed in the tributary basins and in the aqueduct service area. The purpose of the tributary storage would be to divert and store excess runoff for release when Delta outflow or Delta export pumping could be augmented to provide additional beneficial uses.

Some additional water may be obtained from increased export pumping capacity under Alternative 1. More water supply benefits may be obtained if additional in-Delta or aqueduct storage is constructed under Alternative 1. Additional water for allocation to either water supply or instream flow purposes may be obtained from new storage facilities. The opportunity for improved water management with additional facilities will be evaluated in greater detail as the likely set of facilities are identified for each of the basic CALFED alternatives.

Table 14 provides an annual summary of simulated Delta export deliveries for the CALFED alternatives. Results from DWRSIM 472B indicate that simulated exports with increased export pumping capacity would allow an average increase in exports of about 200 TAF. Results from DWRSIM 510 indicate that new storage along with the increased pumping capacity would provide considerable additional water supply reliability benefits, increasing the average annual deliveries from 6.1 MAF to about 6.7 MAF. Figure 71 shows a graphical comparison of annual simulated deliveries.

The upstream storage would also provide some managed water supply for instream flows. Additional aqueduct storage would allow the pumping to be shifted away from months with greatest entrainment or water quality impacts to months with reduced entrainment or water quality impacts.

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

Alternative 2 would modify the Delta channels to allow a much greater through-Delta transport of water. An in-Delta storage facility and larger new aqueduct storage capacity is possible under Alternative 2. There may be substantial benefits associated with land use changes and both terrestrial and aquatic habitat improvements. There may be some water quality benefits from reduced agricultural drainage and there is the possibility of reduced salinity intrusion resulting from changes in the tidal flows and mixing between the Suisun Bay and central Delta. However, there are no distinct water supply benefits associated with Alternative 2 compared to Alternative 1 because the same potential for increasing the permitted Delta export pumping capacity and constructing additional upstream and aqueduct storage may be included in both Alternative 1 and Alternative 2;

therefore, the same range of potential water supply benefits (compared with the No-Action Alternative) is possible for Alternative 2 as for Alternative 1 (Table 14).

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

Alternative 3 includes the potential Delta channel modifications as listed under Alternative 2, but may also include an isolated transfer facility to allow diversion of a portion of the Delta exports from the vicinity of Hood. The will certainly have water quality benefits and may have substantial fishery benefits from reduced entrainment impacts at the existing south Delta exports; however, there are no distinct water supply benefits associated with Alternative 3 compared with Alternative 1 and Alternative 2 unless the Delta water quality objectives are modified.

Because there may be justification for allowing higher exports with an isolated facility (i.e., higher export/inflow ratios), there may be some increased water supply opportunities; however, the possibility of increasing the export/inflow ratio for an isolated facility has not been thoroughly investigated, so the potential water supply benefits have not been determined. Because the same range of benefits from storage facilities and increased export capacity can be achieved with each of the alternatives, the only distinct feature of Alternative 3 is the possibility of relaxing the export/inflow ratio. This may not provide a very large increment of water supply reliability once these other improvements (storage and pumping capacity) are accomplished.

Table 14 shows the simulated aqueduct deliveries for several DWRSIM results that included maximum physical pumping capacity with a 5,000-cfs capacity isolated conveyance component (DWRSIM 475) and isolated conveyance facility with new storage facilities (DWRSIM 500). None of these simulations includes relaxed Delta outflow or export/inflow objectives. Results from DWRSIM 475 indicate that the isolated facility does not increase the potential exports beyond that provided by physical pumping capacity. Results from DWRSIM 500 indicate that the isolated conveyance facility would not further increase the water supply benefits associated with maximum pumping capacity and new storage facilities (DWRSIM 510) unless the export/inflow ratio or the required Delta outflow was relaxed.

STANISLAUS RIVER WATER SUPPLY AND WATER MANAGEMENT

OVERVIEW

The Stanislaus River has a watershed area of about 1,100 square miles, draining the Sierra Nevada Mountains and foothills, with maximum elevations of about 10,000 feet as shown in Figure 70. The major reservoir is New Melones, constructed in 1979 (but not filled until 1981), with a capacity of 2.4 MAF. Several upstream reservoirs have a combined capacity of about 400 TAF.

Turlock Reservoir, located downstream of New Melones, has a storage capacity of about 70 TAF. Goodwin Dam is the major diversion dam on the Stanislaus River and is the upstream migration barrier for anadromous fish.

WATERSHED RUNOFF CHARACTERISTICS

Table 15 gives the historical runoff and water management indices for the Stanislaus River for 1957 to 1993. The average annual historical (unimpaired) runoff for this period was about 1,113 TAF, with a range of 155 TAF (in 1977) to more than 2 MAF (in 1969, 1982, and 1983).

Figure 71 shows the monthly distribution of unimpaired flows for 1981-1991. Peak runoff caused by snowmelt occurs from April through June. Rainfall can cause substantial runoff from November through March. Late summer and fall unimpaired flows are relatively low; the median flow is less than 200 cfs from July through October.

WATER MANAGEMENT FACILITIES

The largest reservoir on the Stanislaus River is New Melones, which was completed by the Corps in 1978 and is operated by Reclamation. The reservoir first was filled to capacity in 1993. Reservoir storage was nearly depleted during the 1987-1991 drought.

Tulloch Reservoir has a storage capacity of about 70 TAF. Releases from Tulloch Powerhouse flow downstream to Goodwin Dam, where diversions are made into the Oakdale and South San Joaquin Canals.

There are more than 40 small pump diversions along the Stanislaus River that supply irrigation water during spring and summer.

RESERVOIR STORAGE OPERATIONS

Figure 72 shows the historical monthly range of storage in New Melones for 1981-1991. There is a wide range of monthly storage because of the large component of carryover storage; the reservoir storage remains relatively high in wet years but can be relatively low in dry years.

REGULATED FLOWS AND DIVERSIONS

Figure 73 shows the historical monthly diversions at the Goodwin Dam for 1962-1992. Maximum monthly diversions are about 100 TAF during the irrigation season from May through August. The New Melones Reservoir allows the reliability of these diversions to be increased.

Salmon spawn in the 23-mile reach between Goodwin Dam and Riverbank, and rear in the entire lower Stanislaus River. Current instream flow requirements vary from about 135 cfs (average in dry years) to about 415 cfs (average in wet years). The monthly flow schedule, specified by DFG, emphasizes fall and winter conditions for fall-run salmon. A minimum of 70 TAF is also allocated for water quality benefits (i.e., salinity control) at Vernalis. This increases the releases during the irrigation months by an average of 200 cfs. DFG and AFRP recommend that spring releases for outmigration are the greatest additional flow needs for the Stanislaus River. An adaptive management framework, with releases that depend on available water supply, has been suggested by AFRP. Because of the water rights and contract obligations, additional instream flow requirements may be difficult to achieve in some years.

Below the major diversions at Goodwin Dam there are several riparian diversions, but the streamflow near the mouth of the Stanislaus River between 1981 and 1991 has averaged about 680 TAF (938 cfs average).

Figure 74 shows the monthly distribution of historical flows near the mouth of the Stanislaus River at Ripon for 1981-1991. The highest flows occur during winter from rainfall storms. The snowmelt and rainfall runoff from the upper watershed, however, are generally captured and released for irrigation diversions. Summer historical flows at Ripon have generally been greater than 200 cfs, which is much higher than unimpaired flows, because of the reservoir releases for water quality control.

HISTORICAL WATER MANAGEMENT ALLOCATION

Figure 75 shows the monthly water allocation for the Stanislaus River for 1982-1991. The reservoir was first filled in 1983 and remained at fairly high storage levels through 1986. The reservoir storage then declined from 1987 through 1991 during the drought. In wet years, when the inflows are greater than beneficial uses, New Melones Reservoir storage increases to the flood control capacity. During summer months, storage releases from New Melones are needed to supply beneficial uses along the Stanislaus River.

Table 15 gives the summary of historical water allocation. The Old Melones Reservoir provided some seasonal storage capacity prior to the completion of New Melones Reservoir. The historical water allocation has been approximately 194 TAF for estimated instream flow use (17% of the runoff) and about 522 TAF (47% of the runoff) for diversions. An additional release for downstream water quality control has been made since 1982. Releases were made prior to 1982 for flood control purposes. An average of 67% of Stanislaus runoff is allocated for beneficial uses, and an average of about 25% of the historical water uses were supplied from reservoir releases.

NO-ACTION WATER MANAGEMENT ALLOCATION

Figure 76 shows the simulated No-Action monthly water allocation for the Stanislaus River for 1982-1991. The reservoir storage pattern is similar to the historical pattern, but because the simulated carryover storage at the end of 1981 was about 1.3 MAF, the simulated storage levels were higher in 1982 and 1983 and more flood control spills were simulated. The simulated carryover storage benefits during the drought from 1987 to 1991 were similar to the historical drawdown.

Figure 77 shows the monthly distribution of simulated Stanislaus River diversions for the No-Action Alternative. The diversion pattern follows the irrigation demands, with more than 100 TAF diverted from April through September. Deficits were simulated in about 50% of the years. Diversions in the remaining months are less than 30 TAF (500 cfs) The maximum monthly diversions of about 150 TAF (2,500 cfs) occur in May, June, and July.

Figure 78 shows the distribution of monthly Stanislaus River flows downstream of the diversions simulated for the No-Action Alternative. The maximum monthly instream flow requirements are shown for reference. Flows that are greater than necessary for instream flows are simulated to occur about 90% of the time, except in April and May when pulse flows depend on available runoff. These excess riverflows represent water quality releases in summer months or flood control releases in winter months.

Table 16 gives the annual Stanislaus River water management allocation summary as simulated for the No-Action Alternative. The average inflow for 1922-1994 was 1,240 TAF, with a range of 415 TAF to 3,100 TAF. The No-Action simulation results indicate that an average of 385 TAF of the New Melones inflow is stored and later released for beneficial uses or released downstream as excess flows. The simulated carryover storage sequence indicates that an average of about 185 TAF of carryover storage is used to augment water supply in dry years. The remaining 200 TAF is used for seasonal storage and releases. Total water use (for instream flow and diversions) in the Stanislaus River basin averages 900 TAF. On average, 675 TAF of this water can be supplied directly by runoff. Therefore the remaining 225 TAF of water used must be supplied from New Melones storage releases; consequently, an average of 160 TAF of the 285 TAF of reservoir releases are used for downstream water quality control or are made for flood control purposes.

The fraction of total runoff that is used for beneficial uses therefore ranges from less than 50% in several wet years to more than 125% in several dry years (when carryover storage is used), with an average use of 72% of the inflow. Because the downstream releases for water quality control are not included as basin uses, the actual use of Stanislaus River water is even higher than indicated by these allocation indices.

Figure 79 shows the annual allocation of Stanislaus River water for the No-Action Alternative as simulated by DWRSIM. A large fraction of the runoff (average of 57% of inflow) is used for water supply diversions. An average of 15% of runoff is used for instream flows, although additional releases for water quality control (shown as excess releases) provides additional instream flow benefits along the Stanislaus River.

Figure 80 shows that the No-Action values for New Melones carryover storage were very similar to the historical carryover storage values for 1982-1993. Figure 81 indicates that the simulated diversions were somewhat larger than the historical diversions, although the periods of deficits were about the same. The historical diversions were quite large even without New Melones Reservoir (prior to 1982).

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Under Alternative 1, the simulated flow and storage values for the Stanislaus River would be similar to those simulated for the No-Action Alternative. There is relatively little unused water from the Stanislaus River because of the high diversions and large New Melones storage capacity that already captures a substantial portion of wet-year flows.

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The few remaining opportunities for improved water management in the Stanislaus River basin under Alternative 2 are the same as those described for Alternative 1.

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

The opportunities for improved water management under Alternative 3 are the same as those described for Alternative 1.

TUOLUMNE RIVER WATER SUPPLY AND WATER MANAGEMENT

OVERVIEW

The Tuolumne River has a watershed of about 1,900 square miles that drains the Sierra Nevada Mountains and foothills, including the north half of Yosemite National Park (Figure 82). Water is impounded and regulated by several dams in the high Sierra for municipal water supply and power generation, most notably Hetch-Hetchy Reservoir, operated by the City and County of San Francisco. Downstream of the San Francisco facilities, Tuolumne River water is impounded and regulated by New Don Pedro Reservoir. Water released from New Don Pedro Reservoir is diverted at La Grange Reservoir into the Turlock and Modesto Canals by the Turlock and Modesto Irrigation Districts.

La Grange Dam is the upstream limit for anadromous fish on the Tuolumne River. Salmon spawn in the 25-mile reach between La Grange Dam and the town of Waterford, and rear in the entire lower Tuolumne River.

WATERSHED RUNOFF CHARACTERISTICS

Table 17 gives the historical runoff and water management indices for the Tuolumne River from 1972 to 1992. The average annual historical (unimpaired) runoff for this period was about 1,800 TAF (2,500 cfs), with a range of 383 TAF (1977) to about 4.6 MAF (1983). The inflow to New Don Pedro Reservoir is affected by San Francisco's upstream reservoirs and diversions. Total annual inflow to New Don Pedro Reservoir, as estimated for the No-Action Alternative (Table 17) or as estimated from reservoir outflow and change in storage (Table 18), indicate that estimated inflow is about 275 TAF less than the unimpaired inflow.

Figure 83 shows the monthly distribution of estimated inflows for 1922-1994. Peak runoff caused by snowmelt occurs in April and June. Rainfall can cause substantial runoff from December through March. Late summer and fall inflows are relatively low; the median inflow is less than 50 TAF (800 cfs) from July through December.

WATER MANAGEMENT FACILITIES

The Hetch-Hetchy Reservoir (located in Yosemite National Park) was constructed by the City and County of San Francisco in 1923 for drinking water supply with a capacity of about 360 TAF. Cherry Lake (260-TAF capacity) was completed in 1953 to increase the aqueduct yield to the maximum of about 300 cfs (220 TAF per year) that is currently exported in the Hetch-Hetchy Aqueduct to San Francisco.

New Don Pedro Reservoir was completed in 1971 by the Turlock and Modesto Irrigation Districts to increase the reliability of water supply diversions. A smaller reservoir with a storage capacity of 290 TAF was operated beginning in 1923. New Don Pedro Reservoir has a capacity of about 2.0 MAF and allows the diversion of about 900 TAF each year from La Grange Dam, located downstream of New Don Pedro Reservoir.

RESERVOIR STORAGE OPERATIONS

Figure 84 shows historical end-of-month New Don Pedro Reservoir storage exceedance values for 1972-1992. The graph shows that reservoir storage capacity (2 MAF) is moderate compared with average reservoir inflow (1.5 MAF) so that the reservoir stays well below capacity during dry years, but can not hold all inflow during the wetter years.

Total storage release (i.e., water from current seasonal runoff plus water saved from the previous year) ranges from 93 TAF to 910 TAF, with an average of 420 TAF. The reservoir is large enough to provide moderate carryover storage benefits. Average carryover storage (i.e., end-of-September storage) is 1,184 TAF. This carryover storage is sometimes used to provide releases the following year. An average of about 166 TAF of carryover storage is used in the subsequent year, so the average use of seasonal storage is 254 TAF (420-166 TAF). Table 18 indicates that New Don Pedro Reservoir storage is needed to supply an average of about 30% (310 TAF) of the combined historical diversion and instream flow uses, which total about 1,100 TAF.

REGULATED FLOWS AND DIVERSIONS

Almost all diversions from the Tuolumne River below New Don Pedro Reservoir are made by the Modesto and Turlock Irrigation Districts. Figure 85 shows the monthly distribution of these diversions for 1972-1992. Maximum diversions generally peak in July with a median diversion of approximately 175 TAF. The combined annual diversions made by these two irrigation districts range from 437 TAF (in 1977) to about 1,100 TAF in several years, with an average of about 900 TAF (Table 18). These average diversions represent 58% of the average estimated inflow. The maximum diversion of 1,194 TAF represents about 77% of the average estimated inflow.

Instream flow requirements for New Don Pedro hydropower Federal Energy Regulatory Commission (FERC) license were quite low (170 cfs average in normal years; 90 cfs average in dry years); however, following studies by DFG, USFWS, City and County of San Francisco, and the irrigation districts, a new adaptive management approach to instream flows (several year-type schedules with temperature-management goals and fish-count monitoring) has been adopted in a revised 1997 FERC license. The flows are specified for the October-March salmon spawning and rearing season and the April and May outmigration pulse and the summer steelhead rearing season. The salmon rearing flows vary from 80 cfs to 300 cfs, with pulse flows of 500 cfs to 3,000 cfs. The summertime steelhead rearing flows vary from 50 cfs to 200 cfs. Because the flows vary with available runoff, the water supply impacts are minimized.

The monthly historical flows below La Grange Dam from 1972-1992 (Figure 86) indicate the efficiency of the water storage and delivery systems on the Tuolumne River. The historical average flow is about 880 cfs, with most of this flow occurring during winter when rainfall storms cause reservoir flood control releases. Summer historical flows (80% exceedance) are only about 20 cfs. Local inflows below La Grange cause the flows at Modesto to be greater than those at La Grange by an average of about 200 TAF per year (Table 18).

HISTORICAL WATER MANAGEMENT ALLOCATION

Figure 87 shows the monthly water allocation for the Tuolumne River for 1982-1991. The inflows are often greater than beneficial uses in winter and spring months and New Don Pedro Reservoir storage sometimes increases to the flood control capacity. During summer months, storage releases from New Don Pedro Reservoir are needed to supply beneficial uses along the Tuolumne River. Occasionally in fall and winter months, the releases are greater than the downstream uses. These releases are made for flood control and hydropower benefits, or may be released downstream as water transfers. The historical water allocation has been approximately 13% of the runoff for instream flow requirements (as estimated by the No-Action Alternative) and about 58% of the runoff for diversions. About 28% of the Tuolumne River historical water uses were supplied from reservoir releases (Table 17).

NO-ACTION WATER MANAGEMENT ALLOCATION

Table 18 gives the annual Tuolumne River water management allocation summary as simulated for the No-Action Alternative. Under the No-Action Alternative, the average simulated New Don Pedro Reservoir inflow for 1922-1994 was 1,542 TAF. Total simulated water use (for instream flow and diversions) averaged 1,121 TAF and ranged from 787 to 1,314 TAF. The fraction of total runoff that is used for beneficial uses therefore ranges from 29% in wet years to 382% in several dry years (when carryover storage is used), with an average use of 73% of the inflow.

The No-Action simulation results indicate that an average of 421 TAF of the New Don Pedro Reservoir inflow are stored and later released for beneficial uses or released downstream as excess flows. The simulated carryover storage sequence indicates that an average of 146 TAF of carryover storage are used to augment water supply in dry years. The remaining 275 TAF are used for seasonal storage and releases. On average, 759 TAF of the 1,121 TAF of water use can be supplied directly by runoff; therefore, the remaining 362 TAF of water used must be supplied from New Don Pedro

Reservoir storage releases. Consequently, an average of 59 TAF of the 421 TAF of reservoir releases are unused in the Tuolumne River basin (generally in wet years).

Figure 88 shows the simulated No-Action monthly water allocation for the Tuolumne River for 1982-1991. The total inflow is compared with the total uses (instream flows and diversions). The inflows are often greater than beneficial uses in winter and spring months; however, during summer months, the storage releases from New Don Pedro Reservoir are needed to supply beneficial uses along the Tuolumne River. Compared to this No-Action allocation, the historical allocation shows more release of water beyond what is used for diversions and instream flow requirements.

Figure 89 shows the monthly distribution of simulated Tuolumne River diversions for the No-Action Alternative. The diversion pattern follows the irrigation demands from April through September. The maximum monthly diversions of about 150 TAF (2,490 cfs) occur in June, July, and August. October through March diversions are generally less than 50 TAF per month (830 cfs).

Figure 90 shows the distribution of monthly Tuolumne River flows downstream of the diversions simulated for the No-Action Alternative. The maximum monthly instream flow requirements are shown for reference. Flows that are greater than necessary for instream flows are simulated to occur less than 50% of the time. These flows represent flood control or hydropower operations that are in excess of the Tuolumne River flow requirements.

Figure 91 summarizes the annual Tuolumne River water allocation as simulated for the No-Action Alternative. Under the No-Action Alternative, the Tuolumne River inflow is often more than the combined uses for instream flow and diversions. The No-Action simulation indicates that an average of 340 TAF of excess flow beyond that required for Tuolumne River uses are available from the Tuolumne River. Table 17 indicates that the excess flow is less than 50 TAF for about half of the years, but during 1983 there was more than 3 MAF in excess flow.

Excess flows may provide instream flow benefits in the Tuolumne and San Joaquin Rivers and may be diverted along the San Joaquin River or in the Delta. These excess flows may also provide benefits as Delta outflow. Nevertheless, some of these excess flows (especially those resulting from flood control storage reductions) may be available for diversion from the Tuolumne River to an additional storage facility.

Figures 92 and 93 show that the No-Action values for New Don Pedro Reservoir carryover storage and annual Modesto and Turlock Irrigation Districts diversions are similar to the historical values. Historical diversions prior to the construction of New Don Pedro Reservoir in 1971 are only slightly less than the simulated diversions, indicating that the old Don Pedro Reservoir was capable of providing most of the storage capacity needed for diversions. Historical diversions after construction of the New Don Pedro Reservoir are slightly higher than simulated diversions during years with moderate-to-higher carryover storage.

Alternative 1 Water Management Allocation

Under Alternative 1, the simulated flow and storage values for the Tuolumne River are similar to those simulated under the No-Action Alternative; however, Alternative 1 provides opportunities for better use of excess runoff. On average, 73% of the inflow to New Don Pedro Reservoir is used for diversions and instream flow requirements under the No-Action alternative. Under Alternative 1, the percent use could increase if flow allocations for fisheries were increased or if additional storage facilities are constructed in the Tuolumne River basin.

Alternative 2 Water Management Allocation

The opportunities for improved water management under Alternative 2 are the same as those described under Alternative 1.

Alternative 3 Water Management Allocation

The opportunities for improved water management under Alternative 3 are the same as those described under Alternative 1.

Merced River Water Supply and Water Management

Overview

The Merced River has a watershed of about 1,275 square miles and drains the Sierra Nevada Mountains and foothills, including the southern half of Yosemite National Park (Yosemite Valley), as shown in Figure 94. Exchequer Dam (Lake McClure) was completed in 1967 by the Merced Irrigation District to increase the reliability of water supply diversions. Lake McClure has a capacity of about 1 MAF and allows diversions of about 600 TAF each year from Merced Falls and Crocker-Huffman Dams, located downstream of Exchequer Dam. The Crocker-Huffman Dam near the town of Snelling is the upstream limit for anadromous fish on the Merced River. The Merced River Hatchery is located immediately below the Crocker-Huffman Dam.

WATERSHED RUNOFF CHARACTERISTICS

Table 19 gives the historical runoff and water management indices for the Merced River for 1967 to 1991. The average annual historical (unimpaired) runoff for this period was about 1,020 TAF (average flow of 1,410 cfs) with a range of 150 TAF (in 1977) to more than 2 MAF (in 1969 and 1983).

Figure 95 shows the monthly distribution of unimpaired flows for 1972-1992. Peak runoff caused by snowmelt occurs from April through July. Rainfall storms can cause substantial runoff from December through March. Late-summer and fall unimpaired flows are relatively low; the median flow is less than 100 cfs from August through October.

WATER MANAGEMENT FACILITIES

Lake McClure is formed by New Exchequer Dam, which was completed by the Merced Irrigation District in 1967. The storage capacity of Lake McClure is approximately 1 MAF. Diversions are made into the North Canal at the Merced Falls Dam and into the Main Canal at the Crocker-Huffman Dam.

RESERVOIR STORAGE OPERATIONS

Figure 96 shows the historical monthly range of storage in Lake McClure. The available storage is utilized in the majority of years, with maximum storage levels achieved in May and June following the spring snowmelt season. The reservoir is large enough to provide substantial carryover storage benefits. Average carryover storage (i.e., end-of-September storage) is 485 TAF. This carryover storage is sometimes used to provide releases the following year. Table 19 indicates that the annual storage release (i.e., water from current season runoff plus water saved from the previous year) ranges from about 150 TAF to 550 TAF, with an average of 350 TAF. An average of about 125 TAF of carryover storage are used in the subsequent year, so the average use of seasonal storage is about 225 TAF (350-125 TAF).

Table 19 indicates that Lake McClure storage is needed to supply an average of about 40% (230 TAF) of the combined historical diversion and instream flow uses, which total about 600 TAF.

REGULATED FLOWS AND DIVERSIONS

Several diversions are located downstream of Crocker-Huffman Dam. Annual diversion estimates range from about 200 TAF (in 1977) to more than 650 TAF in several years, with an average of about 550 TAF (Table 19). These average diversions represent 54% of the average unimpaired inflow. The maximum diversion of 650 TAF represents about 65% of runoff. Figure 97 shows the historical range of monthly diversions from the Merced River. Maximum diversions occur in July and August, the peak irrigation months.

Instream flow requirements for the New Exchequer and McSwain hydropower FERC license are relatively low. The instream flow requirements are estimated to range from 35 TAF in dry years to about 50 TAF in wet years, with an average estimated requirement of 42 TAF (58 cfs). The Davis-Grunsky contract between DFG and Merced Irrigation District includes flow requirements of 200 cfs from November through March; however, these are not included in the No-Action DWRSIM simulations, so the actual instream flow requirements may be somewhat higher than those simulated by DWRSIM.

DFG and AFRP have suggested instream flows that depend on available runoff. DFG and AFRP flows are specified for the October-March salmon spawning and rearing season, the April and May outmigration pulse period, and the summer steelhead rearing season. DFG recommended salmon rearing flows vary from 200 cfs to 300 cfs, with pulse flows of 300 cfs to 500 cfs, and summer flows of 200 cfs to 300 cfs. Additional flow for temperature control may be required in April and May. AFRP recommended considerably greater releases during years with higher runoff. Because the recommended streamflows vary with available runoff, the water supply impacts are thought to be minimized. The increased flows should be effective in helping restore channel and riparian habitat conditions, but have not been included in the DWRSIM simulations of CALFED alternatives.

Below the major Merced River diversions, the total downstream flow between 1967 (when McClure was completed) and 1991 has averaged 428 TAF (590 cfs average). Downstream riparian diversions are estimated to require about 30 TAF; therefore, an average of about 350 TAF were released from the reservoir for hydropower or flood control operations in excess of requirements for diversions or instream flows. At the mouth (near Stevinson), average flow was higher, about 502 TAF (695 cfs average) for 1967-1991, indicating that some of this flow is contributed by irrigation return flows along the lower Merced River.

Figure 98 shows the monthly distribution of historical flows near the mouth of the Merced River near Stevinson for 1972-1992. The highest flows occur during winter when rainfall storms require reservoir flood control releases. The unimpaired flows, however, are generally captured and released for irrigation diversions. Summer historical flows at Stevinson are generally less than 50 cfs, and median flows during the October-March salmon spawning and rearing season are between 250 cfs and 500 cfs.

HISTORICAL WATER MANAGEMENT ALLOCATION

Figure 99 shows the monthly water allocation for the Merced River for 1982-1991. The inflows are often greater than beneficial uses in winter and spring months, and Lake McClure storage often increases to the flood control capacity. During summer months, storage releases from McClure are needed to supply beneficial uses along the Merced River. Sometimes in fall months, the releases are greater than the downstream uses. These releases are made for flood control and hydropower benefits, or may be released downstream as water transfers. The historical water allocation has been approximately 4% of the runoff for instream flows and about 54% of the runoff for diversions. About 40% of the Merced River historical water uses were supplied from reservoir releases (Table 19).

NO-ACTION WATER MANAGEMENT ALLOCATION

Figure 100 shows the simulated No-Action monthly water allocation for the Merced River for 1982-1991. The total inflow is compared with the total uses (instream flows and diversions). The inflows are often greater than beneficial uses in winter and spring months; however, during summer months the storage releases from McClure are needed to supply beneficial uses along the Merced River.

Figure 101 shows the monthly distribution of simulated Merced River diversions for the No-Action Alternative. The diversion pattern follows the irrigation demands from April through September. Diversions in the remaining months are less than 30 TAF (500 cfs). The maximum monthly diversions of about 110 TAF (1,800 cfs) occur in May, June, and July.

Figure 102 shows the distribution of monthly Merced River flows downstream of the diversions simulated for the No-Action Alternative. The maximum monthly instream flow requirements are shown for reference. Flows that are greater than necessary for instream flows are simulated to occur about 90% of the time. These flows represent flood control or hydropower operations that are in excess of the Merced River flow requirements.

Figure 103 shows the annual allocation of Merced River water for the No-Action Alternative as simulated by DWRSIM. Table 20 gives the annual Merced River water management allocation summary as simulated for the No-Action Alternative. The No-Action simulation results indicate that an average of 280 TAF of the McClure inflow are stored and later released for beneficial uses or released downstream as excess flows. The simulated carryover storage sequence indicates that an average of about 90 TAF of carryover storage are used to augment water supply in dry years. The remaining 190 TAF are used for seasonal storage and releases. Total water use (for instream flow and diversions) in the Merced River basin averages 570 TAF. On average, 380 TAF of this water can be supplied directly by runoff; therefore the remaining 190 TAF of water used must be supplied from Lake McClure storage releases. Consequently, an average of 90 TAF of the 280 TAF of reservoir releases are unused in the Merced River basin (generally in wet years).

Figures 104 and 105 show that the No-Action values for Lake McClure carryover storage and annual Merced Irrigation District diversions are similar, but not identical to, the values for historical Lake McClure carryover storage and annual Merced Irrigation District diversion. Under historical conditions, diversions were often slightly greater than those simulated in the No-Action Alternative, although, during drought conditions, the historical diversions tend to be lower than under the No-Action Alternative. Conversely, historical reservoir carryover storage tends to be lower than under the No-Action Alternative.

Under the No-Action Alternative, the average simulated McClure inflow for 1922-1994 was 915 TAF. Total simulated diversions averaged 525 TAF and the average simulated instream flow allocation below the Merced Irrigation District diversions was 43 TAF. When these two beneficial uses are added together, the total annual Merced River uses range from 395 TAF to 647 TAF, with an average total use of 567 TAF. The fraction of total runoff for beneficial uses therefore ranges from less than 25% in wet years to more than 300% in several dry years (when carryover storage is used), with an average use of 62% of the inflow.

Under the No-Action Alternative, the Merced River inflow is usually more than the combined uses for instream flow and diversions. The No-Action simulation indicates that an average of 315 TAF of excess flow beyond that required for Merced River uses are available from the Merced River. Table 20 indicates that the excess flow is less than 50 TAF for 15 of the drier years, but, during wet years, there may be 2 MAF in excess flow (as in 1983).

Excess flows may provide instream flow benefits in the Merced and San Joaquin Rivers and may be diverted along the San Joaquin River or in the Delta. These excess flows may also provide benefits as Delta outflow. Nevertheless, some of these excess flows (especially those resulting from flood control storage reductions) may be available for diversion from the Merced River to an additional storage facility.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Under Alternative 1, the simulated flow and storage values for the Merced River would be similar to those simulated for the No-Action Alternative; however, Alternative 1 provides opportunities for better use of excess runoff. On average, only 62% of the inflow to Lake McClure is used for diversions and instream flow requirements under the No-Action Alternative. Water transfers from the Merced River to provide downstream flow benefits and/or Delta exports might be possible under Alternative 1. Under Alternative 1, the percent of available water used might be increased if additional water was allocated for instream benefits. Increased conjunctive use is another possibility under Alternative 1.

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The opportunities for improved water management in the Merced River basin under Alternative 2 are the same as those described under Alternative 1. In addition, Alternative 2 could include additional storage facilities in the Merced River basin (i.e., Montgomery Reservoir). If the diversion capacity was 1,000 cfs and the excess flow was greater than 1,000 cfs, approximately 60 TAF could be diverted in a month. The additional water supply could then be allocated to a combination of instream flow and diversion uses.

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

The opportunities for improved water management under Alternative 3 are the same as those described under Alternative 2.

UPPER SAN JOAQUIN RIVER WATER SUPPLY AND WATER MANAGEMENT

OVERVIEW

The San Joaquin River flow, originating in the Sierra Nevada, is regulated by a series of small hydroelectric projects and Friant Dam which forms Millerton Lake (Figure 106). Millerton Lake was constructed by Reclamation in 1941. From Friant Dam, the Madera Canal conveys water north and the Friant-Kern Canal conveys water south to the Bakersfield area. These two canals divert most of the water entering Millerton Lake.

Friant Dam is the upstream barrier for anadromous fish in the San Joaquin River; however, because salmon migrating upstream past the Merced River are not able to successfully spawn and rear, a temporary fish barrier has been installed by DFG just upstream of the Merced River mouth since 1992.

WATERSHED RUNOFF CHARACTERISTICS

Table 21 gives the historical runoff and water management indices for the upper San Joaquin River for 1949 to 1992. For this period, the average annual historical (unimpaired) runoff into Millerton Lake was about 1,730 TAF (2,390 cfs), with a range of 360 TAF (1977) to 4.6 MAF.

Upstream reservoirs may affect Millerton Lake inflow; however, total annual inflow to

Millerton, as estimated for the No-Action Alternative (Table 22) or as estimated from reservoir outflow and change in storage (Table 21), is very similar to the unimpaired inflow.

Figure 107 shows the monthly distribution of estimated inflow for 1922-1994. Peak runoff caused by snowmelt occurs in May and June. Rainfall storms cause only moderate runoff from December through March. Late-summer and fall inflows are relatively low; the median flow is less than 100 TAF from September through February.

WATER MANAGEMENT FACILITIES

Several reservoirs upstream of Friant Dam have a combined storage capacity of about 600 TAF. Millerton Lake stores runoff from 1,638 square miles of the upper San Joaquin River and has a storage capacity of approximately 520 TAF. Because most of the water entering Millerton Lake is diverted through the Madera Canal and from the Friant-Kern Canals, river releases from Friant Dam are typically less than 150 cfs, although they may be much greater during storm events and when runoff is large enough to require spilling. Because most of the San Joaquin River flow is now diverted at Friant Dam, diversions for previous water users (exchange contractors) along the San Joaquin River are now supplied by water pumped at the Tracy Pumping Plant from the Delta into the Delta-Mendota Canal to the Mendota Pool.

RESERVOIR STORAGE OPERATIONS

Figure 108 shows historical end-of-month storage exceedance values for Millerton Lake for 1952-1992. Millerton Lake storage is typically drawn below 200 TAF in fall and median storage reaches a maximum of only about 400 TAF in summer.

Table 21 indicates that total storage release (i.e., water from current season runoff plus water saved from the previous year) ranges from about 80 TAF to 620 TAF, with an average of 360 TAF. The lake is relatively small and provides limited carryover storage benefits. Average carryover storage (i.e., end-of-September storage) is 180 TAF. This carryover storage generally provides only small releases the following year. An average of about 25 TAF of carryover storage are used in the subsequent year, so the average use of seasonal storage is about 335 TAF (i.e., 360-25 TAF). Table 21 indicates that Millerton Lake storage is needed to supply an average of about 20% (240 TAF) of the combined historical diversions from the Friant-Kern and Madera Canals, which total about 1,210 TAF.

Regulated Flows and Diversions

Figure 109 shows the monthly distribution of diversions from the upper San Joaquin River for 1952-1992. Maximum diversions generally peak in July with a median diversion of approximately 225 TAF. The Friant-Kern and Madera Canals support the largest diversions in the upper San Joaquin River. Some of the water diverted by these canals during wet years is used for groundwater recharge. Annual diversion estimates range from about 200 TAF (in 1949) to more than 2,000 TAF in several years, with an average of about 1,200 TAF (Table 21). These average diversions represent 70% of the average unimpaired inflow. The maximum diversion of 2,130 TAF represents about 123% of the average unimpaired runoff.

Below Friant Dam, the total downstream flow between 1949 and 1992 has averaged 508 TAF (700 cfs average), with the highest flows tending to occur in the earlier years because the Delta Mendota Canal was not completed until 1952. There are no instream flow requirements for the San Joaquin River between Friant Dam and the Merced River. Downstream riparian diversions at Gravelly Ford are estimated to require about 100 TAF. Since 1958, reservoir releases have been made in less than half of the years for flood control operations.

Figure 110 shows the monthly distribution of historical Millerton Lake releases for 1952-1992. Average flows below Millerton Lake are skewed by the few years when high flows occurred as a result of reservoir spilling. For most years, release flows are quite low, with 70th percentile flows staying below 450 cfs. During the high-flow years, however, flows are much higher, with 90th percentile flows exceeding 6,900 cfs during the April peak. During the drier years, release flows peak during summer, whereas, during the wetter years, release flows peak in spring with the spring runoff.

Historical Water Management Allocation

Figure 111 shows the monthly water allocation for the upper San Joaquin River for 1982-1991. The inflows are often greater than beneficial uses in winter and spring months, and Millerton Lake storage sometimes increases to the flood control capacity. During summer months, storage releases from Millerton are needed to supply diversions. Occasionally in fall and winter months, the releases are greater than the downstream uses. These releases are made for flood control or may be released downstream as water transfers. The historical water allocation has been approximately 70% of the runoff for Friant-Kern and Madera Canal diversions. About 20% of the upper San Joaquin River historical water uses were supplied from reservoir releases.

NO-ACTION WATER MANAGEMENT ALLOCATION

Table 22 gives the annual upper San Joaquin River water management allocation summary as simulated for the No-Action Alternative. Under the No-Action Alternative, the average simulated Millerton Lake inflow for 1922-1994 was 1,672 TAF. Total simulated diversions averaged 1,415 TAF and ranged from 433 TAF to 2,229 TAF. The fraction of total runoff that is used for beneficial uses therefore ranges from 28% in wet years to 115% in several dry years (when carryover storage is used), with an average use of 85% of the inflow. Part of the reason that this number is higher than the historical percent use of inflow (70%) is that the historical value does not include the use at Gravelly Ford and some of the earlier historical diversions were not yet at current levels.

The No-Action simulation results indicate that an average of 312 TAF of the Millerton Lake inflow are stored and later released for beneficial uses or released downstream as excess flows. The simulated carryover storage sequence indicates that an average of about 24 TAF of carryover storage are used to augment water supply in dry years. The remaining 288 TAF are used for seasonal storage and releases. Total simulated diversions in the upper San Joaquin River basin average 1,415 TAF. On average, 1,143 TAF of this water can be supplied directly by runoff; therefore the remaining 271 TAF of water used must be supplied from Millerton Lake storage releases.

Figure 112 shows the simulated No-Action monthly water allocation for the upper San Joaquin River for 1982-1991. The total inflow is compared with the total uses (in this case, only diversions). The inflows are often greater than beneficial uses in winter and spring months; however, during summer months, the storage releases from Millerton are needed to supply diversions.

Figure 113 shows the monthly distribution of simulated upper San Joaquin River diversions for the No-Action Alternative. The diversion pattern follows the irrigation demands from April through September, although some of this water is used for groundwater recharge in wet years. Diversions in the remaining months are lower, although median diversions during October, February, and March are still 50 TAF or greater. The larger diversions (70th percentile and above) of about 300 TAF (5,000 cfs) occur in June, July, and August.

Figure 114 shows the distribution of monthly Millerton Lake release flows simulated for the No-Action Alternative. No instream flow requirements exist for the upper San Joaquin River below Millerton. During a few years, high release flows result from flood control operations.

Figure 115 summarizes the annual upper San Joaquin River water allocation as simulated for the No-Action Alternative. The Friant-Kern and Madera Canals are quite effective at diverting most of the inflow to Millerton Lake even though the capacity of the lake is relatively small compared to the total inflow volume. The No-Action simulation indicates that an average of 234 TAF of excess flow beyond that required for upper San Joaquin diversions are available from the upper San Joaquin River.

Table 22 indicates that the excess flow is less than 5 TAF for half of the simulated years but, during wet years, there may be more than 3 MAF in excess flow (as in 1983). Because the upper San Joaquin River below Gravelly Ford is often dry, these excess flows provide only limited benefits to the upper river. In addition, these excess flows tend to be limited to the wettest years, when flows in the lower San Joaquin River are probably already adequate for habitat suitability. Some of these excess flows may be available for diversion at the Mendota Pool or to an additional storage facility, but this water would be available only during wet years.

Figures 116 and 117 show that the No-Action values for Millerton Lake carryover storage and annual diversions are similar to the values for historical Millerton Lake carryover storage and annual diversions.

ALTERNATIVE 1 WATER MANAGEMENT ALLOCATION

Under Alternative 1, the simulated flow and storage values for the upper San Joaquin River are similar to those simulated under the No-Action Alternative; however, Alternative 1 provides opportunities for better use of excess runoff. On average, 85% of the inflow to Millerton Lake is used for diversions and instream flow requirements under the No-Action Alternative. Although this is a fairly high percent use, it could be even higher under Alternative 1 if a minimum flow requirement were established for fisheries benefits or if additional storage facilities were constructed in the upper San Joaquin River basin (i.e., enlarged Millerton). Additional conjunctive use is another possibility under Alternative 1; however, DWRSIM assumes that Millerton operations will not be affected or modified by CALFED alternatives.

ALTERNATIVE 2 WATER MANAGEMENT ALLOCATION

The opportunities for improved water management under Alternative 2 are the same as those described under Alternative 1, although no changes are simulated by DWRSIM.

ALTERNATIVE 3 WATER MANAGEMENT ALLOCATION

The opportunities for improved water management under Alternative 3 are the same as those described under Alternative 1. No changes are simulated by DWRSIM.

Table A. Tributary Streams and Reservoirs Included in CALFED Water Management Impact Assessment

Tributary Basin	Watershed Area (square miles)	Unimpaired Runoff (TAF)	Reservoir Name	Reservoir Volume (TAF)	Included in DWRSIM
Trinity	692	1,254	Clair Engle	2,448	Yes
Sacramento	14,050	10,936	Shasta	4,552	Yes
Clear Creek	240	350	Whiskeytown	241	Yes
Stony Creek	775	470	Black Butte	144	No
Feather	5,921	6,845	Oroville	3,538	Yes
Yuba	1,350	2,259	New Bullards Bar	966	No
			Englebright	70	No
Bear	300	312	Camp Far West	104	No
American	1,900	2,675	Folsom	977	Yes
Cache Creek	1,300	560	Clear Lake	313	No
			Indian Valley	300	No
Putah Creek	710	415	Berryessa	1,600	No
Mokelumne	675	700	Pardee	210	No
			Camanche	417	No
Calaveras	375	175	New Hogan	317	No
Stanislaus	1,100	1,239	New Melones	2,420	Yes
			Tulloch	68	No
Tuolumne	1,900	1,542	New Don Pedro	2,030	Yes
Merced	1,275	914	McClure	1,024	Yes
Chowchilla			Eastman	150	Yes
Fresno			Hensley		Yes
San Joaquin	1,650	1,672	Millerton	520	Yes
Kings			Pine Flat	1,000	No
Kern			Isabella	568	No
Delta		21,843	San Luis	2,040	Yes

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Table B. Surface Water Supply Management Indicators for CALFED No-Action Alternative

Tributary Basin	Available Inflow (TAF)	Total Diversions (TAF)	Required Flow (TAF)	Carryover Storage (TAF)	Storage Release (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
Trinity	1,254	892	340	1,329	467	164	36	38	98
Sacramento	10,936	3,250	3,107	2,863	1,462	377	13	20	61
Feather	6,845	2,478	859	2,089	1,152	395	17	26	49
American	2,675	388	1,493	477	472	104	17	17	70
Stanislaus	1,239	708	189	1,329	391	185	32	25	72
Tuolumne	1,542	912	209	1,326	421	146	27	32	73
Merced	914	525	43	642	278	89	30	33	62
San Joaquin	1,672	1,415	0	186	312	24	19	19	85
Delta	21,843	6,404	5,537	630	1,321	135	6	21	60
		plus 1,156 TAF In-Delta diversions							

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Table C. Average Delta Conditions Simulated for CALFED Alternatives

		No-Action	472B	510	475	500
Oct	Inflow	1082	1094	1125	1108	1117
	Export	569	630	657	646	655
	Outflow	439	395	399	393	393
Nov	Inflow	1197	1207	1215	1203	1218
	Export	553	623	643	619	638
	Outflow	601	545	534	545	541
Dec	Inflow	1937	1953	1931	1983	2019
	Export	633	695	718	712	764
	Outflow	1292	1251	1205	1263	1248
Jan.	Inflow	2818	2835	2777	2837	2826
	Export	672	686	755	671	778
	Outflow	2239	2244	2117	2262	2144
Feb	Inflow	3240	3240	3188	3243	3213
	Export	547	543	606	533	627
	Outflow	2752	2760	2645	2772	2648
Mar	Inflow	3092	3089	3049	3095	3067
	Export	549	549	626	558	672
	Outflow	2545	2545	2428	2542	2401
Apr	Inflow	2072	2072	2041	2156	2091
	Export	385	407	412	553	531
	Outflow	1619	1601	1566	1539	1496
May	Inflow	1649	1654	1656	1709	1704
	Export	381	398	407	513	529
	Outflow	1133	1125	1118	1065	1045
Jun	Inflow	1393	1395	1402	1460	1444
	Export	445	464	467	542	525
	Outflow	723	710	714	698	699
Jul	Inflow	1273	1311	1332	1100	1123
	Export	603	649	669	438	462
	Outflow	410	408	409	408	408
Aug	Inflow	971	888	988	836	871
	Export	535	459	558	406	440
	Outflow	255	254	254	255	256
Sep	Inflow	915	903	919	913	912
	Export	532	553	562	569	561
	Outflow	272	244	252	239	245
Total	Inflow	21638	21640	21622	21643	21606
	Export	6404	6656	7080	6759	7183
	Outflow	14280	14082	13640	13982	13522

Table 1. Annual Unimpaired Central Valley Flows

Water Year	Trinity River at Lewiston (TAF)	Sacramento River at Shasta Dam (TAF)	Sacramento River Near Red Bluff (TAF)	Feather River Near Oroville (TAF)	Yuba River at Smartville (TAF)	Bear River Near Wheatland (TAF)	American River at Fair Oaks (TAF)	Sacramento 4 River Index (TAF)	East Side Streams (TAF)	Stanislaus River (TAF)	Tuolumne River (TAF)	Merced River at (TAF)	San Joaquin River at Friant (TAF)	San Joaquin River at Vernalis (TAF)	San Joaquin 4 River Index (TAF)	Delta Total Inflow (TAF)	Tulare Lake Inflow (TAF)
1922	783	4,643	6,711	5,074	2,986	472	3,296	18,067	2,149	1,434	2,478	1,428	2,354	8,726	7,693	33,203	
1923	687	3,654	5,295	3,095	2,071	397	2,750	13,211	1,747	1,127	1,782	941	1,649	6,035	5,499	23,788	
1924	269	2,479	3,299	1,305	606	69	547	5,756	247	261	541	251	442	1,534	1,495	8,194	
1925	1,520	5,160	8,269	3,128	2,162	297	2,760	16,319	1,781	1,233	1,944	916	1,440	5,742	5,533	27,393	
1926	821	3,786	5,788	3,143	1,640	271	1,407	11,979	730	612	1,116	614	1,162	3,647	3,504	18,855	
1927	1,839	7,071	11,138	5,757	3,594	571	3,711	24,201	1,948	1,374	2,066	1,092	2,007	7,070	6,540	39,256	
1928	1,058	5,122	7,641	4,159	2,424	318	2,508	16,733	1,339	947	1,519	735	1,150	4,582	4,350	26,311	
1929	529	3,221	4,431	1,848	1,013	126	1,152	8,444	572	516	977	485	859	2,903	2,838	12,950	
1930	819	4,202	6,118	3,953	1,821	215	1,654	13,546	796	734	1,151	514	860	3,333	3,259	20,377	
1931	403	2,544	3,305	1,447	642	73	718	6,112	275	316	603	262	479	1,677	1,661	8,756	789
1932	717	3,679	5,056	3,312	2,110	250	2,598	13,077	1,520	1,355	2,118	1,115	2,046	7,162	6,634	24,157	3,392
1933	803	3,465	4,584	1,997	1,078	121	1,270	8,929	588	610	1,106	517	1,113	3,442	3,346	14,123	1,966
1934	687	3,337	4,528	2,028	993	124	1,130	8,680	600	429	811	363	692	2,355	2,294	12,972	1,028
1935	971	4,942	7,525	4,280	2,249	358	2,593	16,648	1,529	1,214	2,108	1,172	1,926	6,904	6,421	28,581	2,501
1936	1,027	4,694	7,112	4,311	2,602	437	3,419	17,444	2,437	1,327	2,170	1,160	1,855	7,118	6,512	30,926	3,235
1937	997	4,126	6,004	3,172	1,870	329	2,346	13,392	1,970	1,110	2,012	1,228	2,219	7,590	6,568	25,647	4,364
1938	2,108	9,619	14,801	8,612	4,045	579	4,530	31,988	3,123	2,079	3,432	2,089	3,686	13,404	11,286	57,302	5,696
1939	573	3,464	4,371	1,858	907	120	1,050	8,187	511	527	983	478	921	3,043	2,908	12,757	1,744
1940	1,618	7,064	10,544	5,695	2,867	403	3,412	22,518	1,953	1,399	2,211	1,094	1,877	7,252	6,582	37,323	3,135
1941	2,553	8,757	14,400	6,527	3,156	486	3,163	27,246	1,778	1,336	2,493	1,458	2,652	9,353	7,939	47,051	4,588
1942	1,812	7,698	11,402	6,703	3,430	510	3,945	25,479	2,292	1,487	2,359	1,289	2,255	8,156	7,390	42,683	3,356
1943	1,114	5,892	8,520	5,626	3,134	463	3,874	21,155	2,747	1,554	2,370	1,288	2,051	8,157	7,263	36,905	4,012
1944	654	3,685	4,707	2,865	1,394	189	1,458	10,424	870	672	1,291	682	1,260	4,112	3,904	17,139	2,145
1945	1,058	4,908	6,782	3,784	2,143	296	2,554	15,263	1,772	1,289	2,106	1,109	2,151	7,370	6,655	27,140	3,578
1946	1,411	5,891	8,139	4,172	2,391	316	2,858	17,560	1,575	1,175	1,874	939	1,725	5,997	5,714	28,725	2,695
1947	737	3,923	5,098	2,549	1,372	170	1,424	10,443	641	634	1,094	564	1,124	3,553	3,417	16,287	1,841
1948	1,202	5,401	7,629	3,846	2,005	222	2,236	15,716	1,117	896	1,407	687	1,212	4,329	4,202	23,692	1,647
1949	1,095	4,318	6,026	2,594	1,485	216	1,854	11,959	1,028	744	1,245	637	1,162	3,908	3,788	19,153	1,516
1950	856	4,157	5,765	3,872	2,236	275	2,681	14,553	1,459	1,079	1,552	722	1,315	4,809	4,667	23,473	2,069
1951	1,619	6,351	9,138	5,720	3,552	598	4,640	23,050	3,145	1,694	2,477	1,226	1,859	7,791	7,256	39,242	2,680
1952	1,819	7,792	11,544	7,966	4,120	605	4,972	28,602	3,320	1,915	2,972	1,555	2,829	10,396	9,271	49,207	5,289
1953	1,615	6,523	9,630	5,202	2,550	257	2,653	20,035	1,177	977	1,526	627	1,227	4,522	4,356	30,081	2,094
1954	1,598	6,594	9,366	4,254	1,929	269	2,005	17,554	960	889	1,431	669	1,313	4,444	4,302	26,745	2,198
1955	735	4,116	5,664	2,469	1,284	173	1,564	10,981	934	681	1,124	533	1,161	3,597	3,499	17,226	1,796
1956	2,017	8,804	13,254	7,929	3,932	553	4,610	29,725	3,081	1,869	3,133	1,664	2,945	10,448	9,611	51,211	4,321
1957	1,092	5,406	7,215	3,656	1,972	232	2,147	14,990	1,090	896	1,424	649	1,329	4,407	4,299	22,886	2,045
1958	2,735	9,862	15,423	7,059	3,571	498	4,124	30,177	3,085	1,679	2,641	1,410	2,628	9,243	8,358	51,292	4,374
1959	1,046	5,122	6,801	2,872	1,250	127	1,239	12,162	696	590	997	459	954	3,090	3,000	18,170	1,273
1960	1,028	4,744	6,484	3,239	1,706	185	1,688	13,118	727	595	1,054	484	828	3,051	2,961	19,244	1,220
1961	1,233	5,112	7,231	2,658	1,134	109	1,053	12,075	362	405	733	312	647	2,135	2,098	16,704	872
1962	1,054	5,340	7,579	3,709	1,955	249	2,101	15,345	1,214	1,001	1,785	941	1,937	6,021	5,664	25,610	2,977
1963	1,614	7,048	9,974	6,323	3,302	445	3,595	23,194	1,934	1,279	2,059	995	1,954	6,634	6,287	37,072	3,205
1964	796	3,900	5,209	2,586	1,480	178	1,631	10,907	751	643	1,129	446	920	3,236	3,138	16,641	1,469
1965	1,689	6,973	10,342	6,913	3,863	516	4,464	25,582	2,803	1,745	2,730	1,355	2,267	8,578	8,097	43,295	3,253
1966	1,347	5,318	7,314	2,865	1,426	177	1,395	13,000	820	704	1,307	669	1,298	4,155	3,978	20,784	1,892
1967	1,655	7,419	10,532	6,285	3,300	464	3,962	24,079	2,695	1,927	3,095	1,711	3,220	11,191	9,954	43,824	6,200
1968	1,021	4,791	6,943	3,475	1,585	177	1,712	13,714	809	642	1,008	426	861	3,019	2,938	20,451	1,599
1969	1,752	7,719	11,897	7,079	3,673	564	4,455	27,105	3,257	2,213	3,852	2,192	4,035	15,038	12,293	52,850	8,200
1970	1,586	7,884	11,689	6,250	2,899	369	3,154	23,992	1,995	1,320	1,957	881	1,443	5,875	5,601	37,959	2,384
1971	1,668	7,321	10,765	5,953	2,856	388	2,973	22,547	1,540	1,075	1,684	733	1,417	5,054	4,910	33,839	1,962
1972	1,154	5,069	6,594	3,227	1,716	165	1,868	13,406	882	771	1,202	555	1,036	3,626	3,565	19,832	1,309
1973	1,395	6,208	9,714	4,756	2,668	456	3,017	20,155	2,190	1,284	2,033	1,122	2,047	6,961	6,485	35,070	3,838
1974	2,641	10,780	15,850	8,341	3,972	579	4,265	32,428	2,318	1,556	2,234	1,131	2,183	7,547	7,103	50,215	3,491
1975	1,406	6,435	9,446	4,873	2,382	284	2,624	19,325	1,720	1,249	2,035	1,117	1,795	6,559	6,196	32,060	2,622

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Table 1. Annual Unimpaired Central Valley Flows

Water Year	Trinity River at Lewiston (TAF)	Sacramento River at Shasta Dam (TAF)	Sacramento River Near Red Bluff (TAF)	Feather River Near Oroville (TAF)	Yuba River at Smartville (TAF)	Bear River Near Wheatland (TAF)	American River at Fair Oaks (TAF)	Sacramento 4 River Index (TAF)	East Side Streams (TAF)	Stanislaus River (TAF)	Tuolumne River (TAF)	Merced River at (TAF)	San Joaquin River at Friant (TAF)	San Joaquin River at Vernalis (TAF)	San Joaquin 4 River Index (TAF)	Delta Total Inflow (TAF)	Tulare Lake Inflow (TAF)
1976	670	3,607	4,752	1,846	802	62	799	8,198	328	371	670	298	627	2,015	1,966	11,508	962
1977	201	2,637	3,414	997	371	20	350	5,132	156	155	385	151	362	1,063	1,053	6,810	682
1978	2,055	7,854	12,053	5,688	2,987	416	3,225	23,953	2,198	1,590	2,907	1,759	3,402	11,160	9,659	43,456	5,994
1979	852	4,037	5,658	3,028	1,728	231	2,045	12,460	1,604	1,164	1,913	1,076	1,827	6,423	5,980	23,081	2,909
1980	1,479	6,434	9,752	5,543	3,188	458	3,873	22,355	2,543	1,806	3,043	1,649	2,970	10,587	9,469	41,341	5,756
1981	872	4,124	6,415	2,494	1,105	101	1,133	11,147	692	591	1,054	502.	1,068	3,322	3,215	17,189	1,816
1982	2,030	9,071	13,359	9,062	4,963	746	6,170	33,554	4,227	2,363	3,825	1,957	3,321	12,773	11,466	58,755	5,157
1983	2,993	10,850	17,283	9,453	4,722	714	6,395	37,853	5,524	2,953	4,630	2,790	4,638	18,950	15,011	73,123	8,622
1984	1,552	6,642	9,478	5,746	3,153	392	3,892	22,269	2,504	1,431	2,464	1,175	2,037	8,029	7,107	38,033	3,527
1985	842	3,977	5,526	2,655	1,326	167	1,586	11,093	884	680	1,231	567	1,130	3,722	3,608	17,763	2,358
1986	1,618	7,704	11,186	6,914	3,565	583	4,714	26,379	3,367	1,973	3,009	1,582	3,055	10,932	9,620	47,778	5,612
1987	884	3,958	5,298	2,186	882	90	886	9,251	433	373	664	299	759	2,162	2,095	13,364	1,416
1988	940	3,914	5,383	2,000	915	99	850	9,148	544	378	818	414	860	2,511	2,470	14,012	1,443
1989	1,062	4,734	6,604	3,695	2,223	302	2,243	14,765	990	779	1,312	535	938	3,617	3,564	22,003	1,555
1990	717	3,610	4,731	2,144	1,237	133	1,123	9,235	557	469	845	407	742	2,496	2,464	13,614	1,059
1991	487	3,055	3,996	2,062	1,172	144	1,185	8,415	598	507	1,095	557	1,031	3,302	3,191	13,895	1,757
1992	902	3,636	5,190	1,958	919	124	911	8,978	832	487	835	451	810	2,681	2,583	14,237	1,168
1993	1,753	6,846	10,235	5,691	2,905	386	3,402	22,233	2,673	1,556	2,620	1,529	2,667	8,913	8,373	39,683	4,002
Minimum	201	2,479	3,299	997	371	20	350	5,132	156	155	385	151	362	1,063	1,053	6,810	682
Mean	1,249	5,559	8,068	4,299	2,259	312	2,578	17,204	1,601	1,093	1,804	936	1,695	6,035	5,527	28,698	2,915
Maximum	2,993	10,850	17,283	9,453	4,963	746	6,395	37,853	5,524	2,953	4,630	2,790	4,638	18,950	15,011	73,123	8,622

Table 2. Historical Trinity River Water Allocation (1962 to 1991)

Water Year	Unimpaired Inflow (TAF)	Downstream Flow (TAF)	Required Instream (TAF)	Divert Export (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Fraction of Runoff to Storage (%)	Fraction of Use from Release (%)	Fraction of Runoff Used (%)
									977				
62	1,043	157	157	0	157	152	825	8	1,793	0	79	5	15
63	1,597	862	197	294	492	235	736	333	2,196	0	46	68	31
64	796	159	159	1,235	1,394	684	212	849	1,559	637	27	61	175
65	1,695	129	129	1,105	1,235	674	1,010	571	1,997	0	60	46	73
66	1,345	151	151	1,262	1,413	789	541	658	1,880	117	40	47	105
67	1,653	239	239	1,283	1,521	862	784	695	1,969	0	47	46	92
68	1,012	129	129	1,424	1,554	597	408	989	1,388	581	40	64	154
69	1,751	156	156	1,037	1,193	589	1,152	635	1,905	0	66	53	68
70	1,591	214	214	1,362	1,575	911	673	706	1,871	33	42	45	99
71	1,667	180	180	1,211	1,391	1,026	632	398	2,106	0	38	29	83
72	1,158	123	123	1,182	1,305	634	513	706	1,913	193	44	54	113
73	1,390	133	133	1,220	1,353	812	567	576	1,904	9	41	43	97
74	2,648	706	371	1,799	2,170	1,648	740	648	1,996	0	28	30	82
75	1,405	275	275	1,035	1,311	800	586	541	2,041	0	42	41	93
76	671	127	127	1,039	1,165	368	289	827	1,503	538	43	71	174
77	200	119	119	1,318	1,437	200	0	1,260	242	1,260	0	88	717
78	2,055	178	178	218	396	276	1,752	124	1,870	0	85	31	19
79	853	225	225	783	1,008	248	585	794	1,661	209	69	79	118
80	1,473	323	323	885	1,208	658	802	585	1,879	0	54	48	82
81	864	282	282	710	992	349	501	677	1,702	176	58	68	115
82	2,017	468	468	1,094	1,562	1,107	875	462	2,115	0	43	30	77
83	2,990	1,291	424	1,692	2,116	1,747	508	459	2,164	0	17	22	71
84	1,559	570	270	1,210	1,480	853	552	827	1,889	275	35	56	95
85	838	251	251	674	925	495	324	451	1,762	127	39	49	110
86	1,586	495	325	910	1,235	475	911	771	1,901	0	57	62	78
87	880	309	309	607	916	313	549	637	1,813	88	62	70	104
88	943	256	256	973	1,228	337	583	917	1,479	334	62	75	130
89	1,064	330	330	792	1,122	365	679	782	1,376	103	64	70	105
90	719	233	233	634	867	305	369	583	1,162	214	51	67	121
91	487	271	271	668	939	227	249	741	670	492	51	79	193
Minimum:	200	119	119	0	157	152	0	8	242	0	0	5	15
Average:	1,332	311	233	988	1,222	625	630	640	1,724	180	47	52	92
Maximum:	2,990	1,291	468	1,799	2,170	1,747	1,752	1,260	2,196	1,260	85	88	717

Table 3. Trinity River Water Allocation for No-Action Alternaitve

Water Year	Total Inflow (TAF)	Downstream Flow (TAF)	Required Instream (TAF)	Divert Export (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent of Runoff to Storage (%)	Percent of Uses from Storage (%)	Percent of Runoff Used (%)
									1861				
22	784	340	340	1,119	1,459	738	41	551	1,351	510	5	38	186
23	687	340	340	652	992	581	107	435	1,023	328	16	44	144
24	266	340	340	441	781	216	51	580	494	529	19	74	294
25	1,500	339	339	484	823	607	889	242	1,141	0	59	29	55
26	808	340	340	599	939	469	342	497	986	155	42	53	116
27	1,827	340	340	862	1,202	911	909	315	1,580	0	50	26	66
28	1,058	339	339	944	1,283	798	258	511	1,327	253	24	40	121
29	530	339	339	570	909	516	15	417	925	402	3	46	172
30	815	340	340	456	796	413	404	406	923	2	50	51	98
31	402	340	340	441	781	340	62	456	529	394	15	58	194
32	720	340	340	342	682	405	313	292	550	0	43	43	95
33	806	339	339	354	693	450	348	256	642	0	43	37	86
34	682	339	339	441	780	356	326	440	528	114	48	56	114
35	965	340	340	414	754	514	449	258	719	0	47	34	78
36	1,026	340	340	441	781	534	489	265	943	0	48	34	76
37	999	340	340	483	823	512	478	325	1,096	0	48	39	82
38	2,105	339	339	1,056	1,395	1,032	1,072	396	1,772	0	51	28	66
39	573	339	339	883	1,222	555	18	692	1,098	674	3	57	213
40	1,615	339	339	846	1,185	755	857	458	1,497	0	53	39	73
41	2,549	456	340	1,569	1,909	1,335	1,086	600	1,983	0	43	31	75
42	1,805	340	340	1,622	1,962	1,364	439	628	1,794	189	24	32	109
43	1,109	339	339	1,028	1,367	799	310	599	1,505	289	28	44	123
44	654	339	339	741	1,080	616	37	488	1,054	451	6	45	165
45	1,048	340	340	640	980	700	348	307	1,095	0	33	31	94
46	1,418	339	339	779	1,118	809	606	338	1,363	0	43	30	79
47	732	340	340	696	1,036	598	134	459	1,038	325	18	44	142
48	1,206	340	340	596	936	714	481	240	1,279	0	40	26	78
49	1,096	340	340	695	1,035	642	450	416	1,313	0	41	40	94
50	857	340	340	702	1,042	654	198	408	1,103	210	23	39	122
51	1,611	339	339	937	1,276	911	704	399	1,408	0	44	31	79
52	1,818	340	340	1,037	1,377	1,063	754	345	1,817	0	41	25	76
53	1,611	340	340	1,236	1,576	1,122	475	472	1,820	0	29	30	98
54	1,595	340	340	1,300	1,640	1,034	564	642	1,742	78	35	39	103
55	744	339	339	853	1,192	742	0	475	1,267	475	0	40	160
56	2,027	339	339	1,117	1,456	1,004	1,021	483	1,805	0	50	33	72
57	1,082	340	340	1,028	1,368	808	269	584	1,490	315	25	43	126
58	2,693	409	340	1,764	2,104	1,658	957	472	1,975	0	36	22	78
59	1,042	340	340	1,097	1,437	721	320	744	1,551	424	31	52	138
60	1,025	339	339	886	1,225	717	301	527	1,325	226	29	43	120
61	1,257	340	340	870	1,210	863	388	367	1,346	0	31	30	96
62	1,021	339	339	725	1,064	733	288	358	1,276	70	28	34	104
63	1,655	339	339	960	1,299	946	709	385	1,600	0	43	30	78
64	773	340	340	853	1,193	680	95	539	1,156	444	12	45	154
65	1,745	340	340	937	1,277	892	859	422	1,593	0	49	33	73
66	1,382	340	340	1,028	1,368	932	446	462	1,577	16	32	34	99
67	1,716	340	340	1,108	1,448	1,067	643	407	1,813	0	37	28	84
68	1,106	339	339	1,059	1,398	778	328	651	1,490	323	30	47	126
69	1,845	339	339	1,162	1,501	1,021	822	512	1,800	0	45	34	81
70	1,645	339	339	1,489	1,828	1,153	496	710	1,586	214	30	39	111
71	1,767	340	340	1,216	1,556	1,089	677	500	1,763	0	38	32	88
72	1,233	340	340	1,028	1,368	812	419	586	1,596	167	34	43	111
73	1,472	339	339	1,028	1,367	943	527	454	1,669	0	36	33	93
74	2,801	339	339	2,119	2,458	1,916	876	570	1,975	0	31	23	88
75	1,475	340	340	1,277	1,617	991	470	645	1,800	175	32	40	110
76	730	340	340	914	1,254	730	0	549	1,251	549	0	44	172
77	238	339	339	510	849	238	0	628	623	628	0	74	357
78	2,133	339	339	785	1,124	906	1,217	242	1,598	0	57	22	53
79	897	339	339	823	1,162	635	256	549	1,305	293	29	47	130
80	1,542	339	339	945	1,284	926	621	396	1,530	0	40	31	83
81	866	340	340	876	1,216	628	241	616	1,155	375	28	51	140
82	2,019	339	339	1,014	1,353	971	1,049	416	1,788	0	52	31	67
83	3,073	853	339	1,867	2,206	1,798	738	423	2,103	0	24	19	72
84	1,554	340	340	1,604	1,944	1,333	221	641	1,683	420	14	33	125
85	841	340	340	914	1,254	720	125	563	1,245	438	15	45	149
86	1,603	339	339	931	1,270	743	859	558	1,546	0	54	44	79
87	879	340	340	824	1,164	567	311	622	1,235	311	35	53	132
88	940	339	339	725	1,064	644	300	449	1,086	149	32	42	113
89	1,060	339	339	596	935	568	494	397	1,183	0	47	42	88
90	690	340	340	539	879	546	139	349	973	210	20	40	127
91	471	340	340	441	781	392	80	408	645	328	17	52	166
92	915	339	339	441	780	445	467	353	759	0	51	45	85
93	1,763	339	339	666	1,005	686	1,067	341	1,485	0	61	34	57
94	533	340	340	720	1,060	496	37	586	936	549	7	55	199
Minimum:	238	339	339	342	682	216	0	240	494	0	0	19	53
Average:	1,254	349	340	892	1,232	788	454	467	1,329	164	36	38	98
Maximum:	3,073	853	340	2,119	2,458	1,916	1,217	744	2,103	674	61	74	357

Table 4. Historical Sacramento River Water Allocation

Water Year	Shasta Inflow (TAF)	Trinity Export (TAF)	Grimes Flow (TAF)	Required Instream (TAF)	Total Diversions (TAF)	Total Uses (TAF)	Storage Increases (TAF)	Storage Releases (TAF)	Shasta End-of (TAF)	Carryover Used (TAF)	Fraction of Inflow to Storage (%)	Fraction of Uses from Storage (%)	Fraction of Runoff Used (%)
45	4,858	0	5,109	2,896	1,498	4,394	2,142	860	2,256	0	44	20	90
46	5,906	0	6,594	2,896	1,542	4,438	1,610	1,416	2,450	0	27	32	75
47	3,908	0	4,671	2,896	1,528	4,424	989	1,147	2,292	158	25	26	113
48	5,416	0	6,758	2,904	1,376	4,280	1,464	1,090	2,666	0	27	25	79
49	4,318	0	5,446	2,896	1,652	4,548	1,619	1,700	2,585	81	37	37	105
50	4,133	0	4,861	2,896	1,618	4,514	1,669	1,425	2,829	0	40	32	109
51	6,316	0	7,659	2,896	1,731	4,627	1,356	1,628	2,557	272	21	35	73
52	7,785	0	9,454	2,904	1,599	4,503	2,017	1,143	3,431	0	26	25	58
53	6,540	0	7,459	2,896	1,810	4,706	1,383	1,359	3,456	0	21	29	72
54	6,541	0	7,934	2,896	1,833	4,729	1,276	1,675	3,057	399	20	35	72
55	4,113	0	5,493	2,896	1,836	4,732	870	1,472	2,455	602	21	31	115
56	8,834	0	8,327	2,904	1,646	4,550	2,224	1,111	3,569	0	25	24	52
57	5,369	0	5,927	2,896	1,682	4,578	1,316	1,399	3,485	84	25	31	85
58	9,700	0	10,902	2,896	1,441	4,337	1,233	1,245	3,473	12	13	29	45
59	5,086	0	6,364	2,896	1,939	4,835	925	1,894	2,504	969	18	39	95
60	4,733	0	5,162	2,904	1,921	4,825	1,678	1,426	2,756	0	35	30	102
61	5,073	0	6,680	2,896	1,894	4,790	1,114	1,538	2,333	423	22	32	94
62	5,261	0	5,753	2,896	1,811	4,707	2,107	1,532	2,908	0	40	33	89
63	7,002	294	8,449	2,896	1,507	4,403	1,666	1,332	3,242	0	24	30	63
64	3,905	1,235	6,230	2,904	1,736	4,640	455	1,494	2,202	1,040	12	32	119
65	6,984	1,105	8,163	2,896	1,513	4,409	2,307	897	3,612	0	33	20	63
66	5,299	1,262	8,013	2,896	1,704	4,600	1,403	1,753	3,263	350	26	38	87
67	7,404	1,283	10,515	2,896	1,326	4,222	1,708	1,465	3,506	0	23	35	57
68	4,772	1,424	7,838	2,904	1,797	4,701	741	1,577	2,670	836	16	34	99
69	7,667	1,037	10,153	2,896	1,484	4,380	2,023	1,165	3,528	0	26	27	57
70	7,901	1,362	8,715	2,896	1,594	4,490	1,507	1,594	3,441	87	19	36	57
71	7,327	1,211	10,452	2,896	1,665	4,561	1,406	1,572	3,275	166	19	34	62
72	5,078	1,182	6,705	2,904	1,719	4,623	1,158	1,166	3,267	9	23	25	91
73	6,167	1,220	9,549	2,896	1,686	4,582	1,156	1,105	3,317	0	19	24	74
74	10,796	1,799	12,324	2,896	1,718	4,614	1,656	1,314	3,658	0	15	28	43
75	6,405	1,035	9,338	2,896	1,811	4,707	1,333	1,421	3,570	88	21	30	73
76	3,613	1,039	6,560	2,904	2,110	5,014	179	2,454	1,295	2,275	5	49	139
77	2,636	1,318	3,699	2,896	1,305	4,201	356	1,021	631	665	14	24	159
78	7,833	218	8,174	2,896	1,521	4,417	3,855	1,058	3,428	0	49	24	56
79	4,022	783	5,937	2,896	1,783	4,679	1,026	1,312	3,141	287	26	28	116
80	6,414	885	7,644	2,904	1,503	4,407	1,033	853	3,321	0	16	19	69
81	4,107	710	6,398	2,896	0	2,896	1,130	1,971	2,480	841	28	68	71
82	9,013	1,094	10,905	2,896	0	2,896	2,027	1,021	3,486	0	22	35	32
83	10,795	1,692	13,017	2,896	0	2,896	1,433	1,302	3,617	0	13	45	27
84	6,668	1,210	9,247	2,904	0	2,904	1,000	1,376	3,240	377	15	47	44
85	3,966	674	6,256	2,896	0	2,896	586	1,849	1,977	1,263	15	64	73
86	7,546	910	7,107	2,896	0	2,896	2,215	981	3,211	0	29	34	38
87	3,946	607	5,875	2,896	0	2,896	1,209	2,312	2,108	1,103	31	80	73
88	3,931	973	5,703	2,904	0	2,904	1,474	1,997	1,586	522	38	69	74
89	4,745	792	5,890	2,896	0	2,896	2,205	1,695	2,096	0	46	59	61
90	3,616	634	4,723	2,896	0	2,896	842	1,301	1,637	459	23	45	80
91	3,059	668	4,089	2,896	0	2,896	717	1,015	1,340	298	23	35	95
Minimum	2,636	0	3,699	2,896	0	2,896	179	853	631	0	5	19	27
Average	5,929	988	7,781	2,898	1,043	3,941	1,397	1,430	2,802	355	24	36	66

Table 5. Annual Water Allocation for Sacramento River for No-Action Alternative

Water Year	Shasta Inflow (TAF)	Total Inflow (TAF)	Trinity Export (TAF)	Required Instream (TAF)	Total Divert (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increases (TAF)	Storage Releases (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Fraction of Inflow to Storage (%)	Fraction of Uses from Storage (%)	Fraction of Runoff Used (%)
										2,605				
22	4,548	8,721	1,119	3,615	3,210	6,885	5,338	1,970	1,136	3,421	0	23	22	79
23	3,635	7,270	652	2,896	2,969	6,613	5,086	501	1,689	2,233	1,188	7	23	91
24	2,439	4,243	441	2,896	2,375	5,390	3,621	248	1,525	956	1,277	6	33	127
25	5,035	10,676	484	2,352	2,984	5,500	4,466	2,904	1,243	2,617	0	27	19	52
26	3,711	7,518	599	2,896	3,047	6,274	4,477	1,253	1,817	2,053	564	17	29	83
27	6,917	14,945	862	3,615	3,518	7,193	5,608	2,712	1,318	3,447	0	18	22	48
28	5,105	10,472	944	3,615	3,228	7,114	5,190	1,313	2,006	2,754	693	13	27	68
29	3,176	5,524	570	2,896	2,425	5,756	4,356	353	1,299	1,808	946	6	24	104
30	4,147	7,954	456	2,531	2,564	5,244	4,015	1,955	1,373	2,390	0	25	23	66
31	2,536	4,260	441	2,896	2,164	5,179	3,665	304	1,344	1,350	1,040	7	29	122
32	3,624	6,670	342	2,531	3,209	5,889	4,739	1,174	920	1,604	0	18	20	88
33	3,452	5,902	354	2,531	2,853	5,533	4,448	877	932	1,549	55	15	20	94
34	3,318	5,965	441	2,531	2,227	4,907	3,674	1,130	1,373	1,306	243	19	25	82
35	4,840	10,020	414	2,531	3,111	5,791	4,591	2,496	1,230	2,572	0	25	21	58
36	4,605	9,205	441	2,896	3,412	6,531	4,880	1,790	1,552	2,810	0	19	25	71
37	4,117	7,945	483	2,896	3,105	6,540	4,817	1,498	1,721	2,587	223	19	26	82
38	9,511	21,047	1,056	3,615	3,228	6,903	5,867	2,271	1,158	3,700	0	11	15	33
39	3,470	5,540	883	2,896	3,003	6,647	4,673	526	2,466	1,760	1,940	9	30	120
40	6,998	14,041	846	2,531	3,663	6,343	4,869	2,875	1,415	3,220	0	20	23	45
41	8,701	21,529	1,569	3,615	3,714	7,600	6,407	1,412	932	3,700	0	7	16	35
42	7,603	15,773	1,622	3,615	3,240	7,126	5,997	1,334	1,334	3,700	0	8	16	45
43	5,873	12,192	1,028	3,615	4,003	7,889	6,416	1,334	1,468	3,566	134	11	19	65
44	3,670	6,573	741	2,896	3,292	6,936	5,176	612	1,927	2,251	1,315	9	25	106
45	4,837	8,909	640	2,896	4,031	7,046	5,561	2,306	1,343	3,214	0	26	21	79
46	5,893	11,254	779	2,896	4,169	7,813	6,316	1,218	1,295	3,137	77	11	19	69
47	3,904	6,784	696	2,896	3,253	6,897	5,048	835	1,811	2,161	976	12	27	102
48	5,403	9,645	596	2,896	2,885	5,900	4,823	2,428	1,017	3,572	0	25	18	61
49	4,324	8,146	695	2,896	3,272	6,916	5,330	1,368	2,084	2,856	716	17	23	85
50	4,126	7,534	702	2,896	3,300	6,735	4,928	1,374	1,631	2,599	257	18	27	89
51	6,314	12,004	937	3,615	3,835	7,510	5,844	1,958	1,413	3,144	0	16	22	63
52	7,779	16,051	1,037	3,615	3,778	7,664	6,720	1,479	923	3,700	0	9	12	48
53	6,544	13,601	1,236	3,615	3,582	7,468	6,446	1,334	1,334	3,700	0	10	14	55
54	6,558	12,400	1,300	3,615	3,408	7,294	5,999	1,328	1,518	3,510	190	11	18	59
55	4,111	7,980	853	2,896	3,663	7,307	5,863	923	1,854	2,579	931	12	20	92
56	8,821	18,293	1,117	3,615	3,888	7,563	6,493	2,053	932	3,700	0	11	14	41
57	5,371	9,149	1,028	3,615	3,321	7,207	5,903	1,352	1,495	3,557	143	15	18	79
58	9,696	21,730	1,764	3,615	3,069	6,955	6,234	2,470	2,327	3,700	0	11	10	32
59	5,098	9,027	1,097	2,896	3,670	7,314	5,923	938	1,908	2,730	970	10	19	81
60	4,728	8,520	886	2,896	3,335	6,666	5,223	1,954	1,658	3,026	0	23	22	78
61	5,070	9,512	870	2,896	3,510	7,154	5,744	1,621	1,784	2,863	163	17	20	75
62	5,255	9,944	725	2,896	3,512	6,947	5,485	1,738	1,515	3,086	0	17	21	70
63	7,003	13,099	960	3,615	3,500	7,386	6,185	1,696	1,082	3,700	0	13	16	56
64	3,903	6,776	853	2,896	3,410	7,054	5,211	578	1,990	2,288	1,412	9	26	104
65	6,976	14,572	937	3,615	3,082	6,757	5,475	2,277	963	3,602	0	16	19	46
66	5,319	9,544	1,028	2,896	3,363	7,007	5,551	1,334	1,763	3,173	429	14	21	73
67	7,385	14,234	1,108	3,615	3,150	7,036	5,933	1,571	1,044	3,700	0	11	16	49
68	4,776	9,409	1,059	2,896	3,369	7,013	5,729	1,086	1,585	3,201	499	12	18	75
69	7,666	16,811	1,162	3,615	3,490	7,376	6,510	1,454	955	3,700	0	9	12	44
70	7,904	15,644	1,489	3,615	3,894	7,780	5,957	1,015	1,623	3,092	608	6	23	50
71	7,316	13,907	1,216	3,615	3,371	7,257	6,418	1,535	927	3,700	0	11	12	52
72	5,076	8,423	1,028	2,896	3,453	7,097	5,920	1,334	1,796	3,238	462	16	17	84
73	6,162	13,819	1,028	3,615	3,425	7,311	6,064	1,345	1,113	3,470	0	10	17	53
74	10,782	21,185	2,119	3,615	3,379	7,265	6,606	1,565	1,335	3,700	0	7	9	34
75	6,391	12,808	1,277	3,615	3,383	7,269	6,513	1,503	1,503	3,700	0	12	10	57
76	3,597	6,376	914	2,896	3,152	6,796	5,662	403	1,836	2,267	1,433	6	17	107
77	2,625	4,174	510	2,896	2,185	5,200	3,967	45	1,490	822	1,445	1	24	125
78	7,827	16,632	785	2,352	3,373	5,889	5,169	3,871	993	3,700	0	23	12	35
79	4,025	8,199	823	2,896	3,488	7,132	5,547	1,239	1,800	3,139	561	15	22	87
80	6,418	13,901	945	3,615	3,213	7,099	5,907	1,587	1,087	3,639	0	11	17	51
81	4,099	8,471	876	2,896	3,141	6,785	5,142	1,259	2,041	2,857	782	15	24	80
82	9,014	18,282	1,014	3,615	3,311	6,988	6,276	1,878	1,035	3,700	0	10	10	38
83	10,797	25,102	1,867	3,615	3,408	7,294	6,881	1,419	1,419	3,700	0	6	6	29
84	6,668	13,947	1,604	3,615	3,485	7,371	6,423	1,334	1,334	3,700	0	10	13	53
85	3,972	7,616	914	2,896	3,550	7,194	5,683	637	2,005	2,332	1,368	8	21	94
86	7,548	15,232	931	3,615	3,209	6,884	5,506	1,734	1,098	2,968	0	11	20	45
87	3,945	7,315	824	2,896	3,192	6,733	5,058	1,017	2,107	1,878	1,090	14	25	92
88	3,933	7,471	725	2,531	2,855	5,535	4,449	1,362	1,582	1,658	220	18	20	74
89	4,757	8,869	596	2,531	2,704	5,384	4,360	2,570	1,326	2,902	0	29	19	61
90	3,618	6,550	539	2,896	2,911	6,452	5,184	504	1,438	1,968	934	8	20	99
91	3,055	5,981	441	2,896	2,910	5,925	4,475	711	1,107	1,572	396	12	24	99
92	3,591	7,158	441	2,531	2,607	5,287	4,047	1,536	1,298	1,810	0	21	23	74
93	6,824	16,161	666	2,531	3,618	6,298	5,542	2,886	824	3,872	0	18	12	39
94	3,093	6,179	720	2,896	2,659	6,303	4,853	339	2,173	2,038	1,834	5	23	102
Minimum	2,439	4,174	342	2,352	2,164	4,907	3,621	45	824	822	0	1	6	29
Average:	5,492	10,936	892	3,107	3,250	6,716	5,404	1,454	1,462	2,863	377	13	20	61
Maximum	10,797	25,102	2,119	3,615	4,169	7,889	6,881	3,871	2,466	3,872	1,940	29	33	127

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Table 6. Potential Annual Diversions of Excess Sacramento River Flows and and Delta Surplus Flows for No-Action Alternative

Water Year	Sacramento Excess Flow (TAF)	Sacramento & Delta Surplus (TAF)	Diversions with 5,000 cfs Minimum (TAF)	Diversions with 10,000 cfs Minimum (TAF)	Diversions with 15,000 cfs Minimum (TAF)	Diversions with 20,00 cfs Minimum (TAF)
22	1,984	1,928	1,420	416	92	0
23	3,219	2,187	1,443	599	145	0
24	683	276	276	0	0	0
25	4,019	2,442	680	511	300	300
26	2,714	1,878	974	324	300	280
27	7,251	6,733	1,753	1,165	733	559
28	5,250	3,975	1,752	813	319	300
29	1,690	530	530	0	0	0
30	2,785	1,246	795	389	62	0
31	635	71	71	0	0	0
32	1,045	708	598	110	0	0
33	901	275	275	0	0	0
34	1,892	265	265	0	0	0
35	3,543	2,323	900	775	312	300
36	3,087	2,650	1,004	600	521	300
37	2,631	2,065	1,105	650	310	0
38	13,802	13,692	2,484	2,013	1,394	1,200
39	2,455	1,741	1,522	219	0	0
40	6,457	5,687	1,200	1,200	1,065	676
41	14,879	14,431	2,118	1,800	1,756	1,500
42	10,408	10,211	2,625	1,702	1,063	900
43	5,800	5,557	2,100	1,229	900	636
44	2,396	1,512	1,104	408	0	0
45	2,346	1,586	967	436	183	0
46	5,151	4,189	1,254	644	600	413
47	2,326	1,070	951	119	0	0
48	3,087	2,023	1,200	614	209	0
49	3,335	1,808	820	300	300	300
50	2,247	1,632	992	522	118	0
51	5,065	4,822	1,714	1,024	900	736
52	8,918	8,724	2,381	1,675	1,500	1,485
53	7,486	6,959	2,489	887	600	600
54	6,527	5,311	1,633	1,200	1,200	633
55	3,152	1,774	1,110	561	103	0
56	10,678	10,442	2,115	1,500	939	900
57	3,416	2,476	1,419	658	300	99
58	16,389	15,650	3,009	2,063	1,200	1,200
59	4,681	2,952	1,074	790	536	300
60	2,819	1,120	651	300	169	0
61	4,118	1,461	863	300	298	0
62	3,978	1,707	411	300	300	300
63	6,628	6,147	2,191	1,168	683	576
64	2,742	1,806	1,153	479	174	0
65	6,975	6,186	1,240	991	900	840
66	4,672	3,604	1,667	1,200	737	0
67	7,930	7,735	2,642	1,851	1,748	1,239
68	4,701	3,708	1,497	1,015	375	300
69	10,300	9,836	2,275	1,739	1,354	857
70	10,527	10,060	1,751	1,324	1,037	900
71	7,378	6,468	1,992	1,270	932	900
72	3,580	2,127	1,517	368	242	0
73	7,490	7,066	1,815	1,478	984	900
74	15,674	15,201	2,627	1,877	1,746	1,500
75	6,967	6,519	2,628	977	600	573
76	2,608	1,505	1,204	301	0	0
77	947	0	0	0	0	0
78	8,580	7,110	1,454	1,200	1,200	970
79	3,423	2,129	1,151	751	227	0
80	7,149	6,926	1,643	1,039	900	635
81	4,041	2,599	1,281	900	418	0
82	11,215	10,916	2,324	1,877	1,800	1,673
83	19,928	19,928	3,524	2,835	1,813	1,627
84	8,451	7,873	1,898	1,689	1,107	709
85	3,756	2,708	1,623	614	301	170
86	8,528	8,383	1,298	695	600	600
87	3,347	1,697	933	544	220	0
88	2,959	922	444	300	178	0
89	2,909	1,425	643	303	300	179
90	2,218	666	511	155	0	0
91	1,188	738	382	300	56	0
92	2,168	1,007	579	300	128	0
93	8,400	6,802	1,961	1,398	1,019	900
94	3,147	1,219	874	345	0	0
Minimum	635	0	0	0	0	0
Average:	5,422	4,508	1,380	823	555	410
Maximum	19,928	19,928	3,524	2,835	1,813	1,673

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Table 7. Historic Feather River Water Allocation (Upstream of Yuba River)

Water Year	Unimpaired Oroville Inflow (TAF)	Estimated Oroville Inflow (TAF)	Flow at Gridley (TAF)	Required Instream (TAF)	Total Diversion (TAF)	Total Use (TAF)	Direct Use (TAF)	Oroville Storage Increase (TAF)	Oroville Storage Release (TAF)	Oroville Carryover Storage (TAF)	Carryover Used (TAF)	Percent of Inflow to Storage (%)	Percent of Use from Storage (%)	Percent of Inflow Used (%)
										1,678				
69	7,069	6,477	4,612	978	762	1,740	1,706	1,843	740	2,780	0	28	2	27
70	6,269	5,869	5,371	978	737	1,715	1,573	460	699	2,542	239	8	8	29
71	5,958	5,517	4,575	978	754	1,732	1,732	1,062	874	2,730	0	19	0	31
72	3,233	3,033	2,357	978	795	1,773	1,517	863	981	2,612	119	28	14	58
73	4,741	4,356	3,470	978	769	1,747	1,452	1,079	962	2,729	0	25	17	40
74	8,363	7,979	7,510	978	800	1,778	1,756	929	1,261	2,397	332	12	1	22
75	4,854	4,630	3,253	978	916	1,894	1,826	1,814	1,353	2,858	0	39	4	41
76	1,849	1,837	1,965	978	902	1,880	1,196	277	1,307	1,828	1,030	15	36	102
77	994	724	1,009	694	628	1,322	679	23	936	915	913	3	49	183
78	5,685	4,824	2,252	678	742	1,420	1,247	2,439	610	2,744	0	51	12	29
79	3,023	2,932	2,124	784	880	1,664	1,382	849	921	2,672	72	29	17	57
80	5,533	4,957	4,168	978	850	1,828	1,584	751	812	2,611	61	15	13	37
81	2,478	2,363	1,726	978	894	1,872	1,386	806	1,063	2,354	257	34	26	79
82	8,998	8,474	7,301	784	753	1,537	1,484	1,273	853	2,775	0	15	3	18
83	9,418	9,245	8,603	978	599	1,577	1,577	807	764	2,818	0	9	0	17
84	5,767	5,642	5,113	978	818	1,796	1,713	715	1,004	2,529	289	13	5	32
85	2,642	2,635	2,171	978	861	1,839	1,477	760	1,157	2,132	397	29	20	70
86	6,722	6,223	4,924	978	771	1,749	1,558	1,310	782	2,661	0	21	11	28
87	2,172	1,774	1,631	978	825	1,803	1,097	527	1,210	1,979	682	30	39	102
88	2,008	1,952	1,561	694	841	1,535	1,080	725	1,174	1,529	450	37	30	79
89	3,697	3,266	1,830	588	814	1,402	1,116	1,837	1,216	2,150	0	56	20	43
90	2,142	1,940	2,101	588	826	1,414	1,086	203	1,190	1,163	987	10	23	73
91	2,066	1,880	1,107	588	537	1,125	980	785	549	1,399	0	42	13	60
Minimum	994	724	1,009	588	537	1,125	679	23	549	915	0	3	0	17
Average	4,595	4,284	3,510	873	786	1,658	1,400	963	975	2,300	253	22	16	39
Maximum	9,418	9,245	8,603	978	916	1,894	1,826	2,439	1,353	2,858	1,030	56	49	183

Table 8. No Action Feather River Water Allocation

Water Year	Oroville Inflow (TAF)	Total Inflow (TAF)	Flow At Gridley (TAF)	Required Instream (TAF)	Thermalito Diversions (TAF)	Total Diversions (TAF)	Total Uses (TAF)	Direct Uses (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent of Inflow to Storage (%)	Percent of Uses from Storage (%)	Percent of Inflow Used (%)
											2,551				
22	4,786	8,585	3,478	978	1,020	2,728	3,706	3,383	1,114	846	2,819	0	13	9	43
23	2,967	4,909	2,684	978	1,021	2,451	3,429	2,593	773	1,589	2,003	816	16	24	70
24	1,482	2,595	1,675	888	832	2,369	3,257	1,971	229	1,296	936	1,067	9	39	126
25	2,785	4,717	878	588	1,020	2,351	2,939	2,021	1,236	552	1,620	0	26	31	62
26	2,844	4,583	1,862	588	1,020	2,511	3,099	1,832	1,586	1,122	2,084	0	35	41	68
27	4,985	9,707	3,199	678	1,020	2,695	3,373	2,852	1,643	1,245	2,482	0	17	15	35
28	3,915	6,822	3,725	978	1,020	2,672	3,650	2,641	964	1,814	1,632	850	14	28	54
29	1,869	3,034	1,210	888	834	2,262	3,150	2,211	355	541	1,446	186	12	30	104
30	3,445	5,538	1,706	588	1,011	2,775	3,363	2,421	1,906	1,216	2,136	0	34	28	61
31	1,617	2,619	1,492	588	834	2,272	2,860	1,759	378	1,135	1,379	757	14	38	109
32	2,911	4,565	1,803	588	1,015	2,799	3,387	2,649	997	909	1,467	0	22	22	74
33	1,935	3,044	1,178	588	834	2,505	3,093	2,367	396	534	1,329	138	13	23	102
34	2,014	3,168	1,279	588	828	2,423	3,011	2,034	609	785	1,153	176	19	32	95
35	3,644	6,439	2,358	678	1,018	2,415	3,093	2,358	1,864	1,250	1,767	0	29	24	48
36	3,808	7,425	2,119	978	1,019	2,500	3,478	2,678	2,039	1,651	2,155	0	27	23	47
37	2,813	5,752	2,097	978	1,034	2,637	3,615	2,662	1,174	1,496	1,833	322	20	26	63
38	7,832	13,920	5,149	978	1,006	2,348	3,326	3,128	1,905	388	3,350	0	14	6	24
39	2,174	3,123	3,600	978	826	2,241	3,219	2,132	0	2,257	1,093	2,257	0	34	103
40	5,083	9,857	3,207	784	1,014	2,537	3,321	2,554	2,341	1,416	2,018	0	24	23	34
41	5,963	10,182	3,883	978	1,007	2,311	3,289	2,944	1,629	815	2,832	0	16	10	32
42	6,355	10,813	5,408	978	1,006	2,294	3,272	2,864	908	916	2,824	8	8	12	30
43	5,414	8,925	4,528	978	1,021	2,527	3,505	2,884	863	1,075	2,612	212	10	18	39
44	2,664	4,295	2,523	978	1,020	2,582	3,560	2,530	816	1,672	1,756	856	19	29	83
45	3,462	5,605	2,295	978	1,021	2,542	3,520	2,630	1,733	1,621	1,868	0	31	25	63
46	3,910	6,424	2,814	978	1,007	2,604	3,582	2,750	1,557	1,536	1,889	0	24	23	56
47	2,456	3,882	1,997	978	1,020	2,558	3,536	2,133	937	1,423	1,403	486	24	40	91
48	3,388	5,460	1,705	784	1,020	2,185	2,969	2,371	1,757	785	2,375	0	32	20	54
49	2,414	3,931	1,885	888	1,020	2,627	3,515	2,517	761	1,383	1,753	622	19	28	89
50	3,533	5,771	1,640	678	1,020	2,610	3,288	2,790	1,938	1,220	2,471	0	34	15	57
51	5,321	10,230	4,060	978	1,004	2,562	3,540	2,848	1,086	1,109	2,448	23	11	20	35
52	7,360	12,983	5,408	978	1,005	2,479	3,457	3,332	1,090	188	3,350	0	8	4	27
53	4,961	7,274	4,468	978	1,007	2,499	3,477	3,205	748	1,283	2,815	535	10	8	48
54	4,120	6,319	4,153	978	1,021	2,467	3,445	2,629	673	1,781	1,707	1,108	11	24	55
55	2,406	3,771	1,604	978	1,022	2,643	3,621	2,602	693	928	1,472	235	18	28	96
56	7,146	11,491	4,558	978	1,008	2,533	3,511	3,179	2,224	701	2,995	0	19	9	31
57	3,630	5,647	3,340	978	1,022	2,446	3,424	2,859	630	1,398	2,227	768	11	17	61
58	6,306	11,098	4,114	978	1,021	2,259	3,237	3,022	1,312	189	3,350	0	12	7	29
59	2,923	4,577	3,556	978	1,022	2,598	3,576	2,456	271	1,955	1,666	1,684	6	31	78
60	2,974	4,202	2,152	784	1,021	2,574	3,358	2,102	1,367	1,370	1,663	3	33	37	80
61	2,407	3,557	1,670	694	1,021	2,579	3,273	2,174	937	1,306	1,294	369	26	34	92
62	3,280	5,177	2,234	588	1,021	2,665	3,253	2,516	1,415	1,246	1,463	0	27	23	63
63	5,907	10,489	3,414	784	1,006	2,306	3,090	2,656	2,220	1,129	2,554	0	21	14	29
64	2,473	4,148	2,220	978	1,021	2,603	3,581	2,580	767	1,565	1,756	798	18	28	86
65	6,302	10,389	4,144	978	1,007	2,497	3,475	3,178	1,758	633	2,881	0	17	9	33
66	2,854	4,745	2,968	978	1,019	2,751	3,729	2,702	564	1,756	1,689	1,192	12	28	79
67	5,784	10,107	3,069	978	1,006	2,367	3,345	3,066	2,140	479	3,350	0	21	8	33
68	3,434	5,163	4,006	978	1,021	2,606	3,584	2,531	166	1,791	1,725	1,625	3	29	69
69	6,517	11,923	4,027	978	1,007	2,536	3,514	3,162	1,813	376	3,162	0	15	10	29
70	5,730	11,077	5,985	978	1,006	2,589	3,567	2,507	403	1,680	1,885	1,277	4	30	32
71	5,336	9,100	3,295	978	1,020	2,622	3,600	3,464	1,725	768	2,842	0	19	4	40
72	2,974	4,866	2,792	978	1,021	2,639	3,617	2,659	537	1,412	1,967	875	11	26	74
73	4,138	8,852	3,004	978	1,020	2,572	3,550	2,865	1,607	1,518	2,056	0	18	19	40
74	7,898	14,071	5,574	978	1,005	2,445	3,423	3,328	1,716	459	3,313	0	12	3	24
75	4,642	7,938	3,786	978	1,020	2,555	3,533	3,361	725	863	3,175	138	9	5	45
76	1,908	3,190	2,455	978	824	2,251	3,229	1,947	24	1,431	1,768	1,407	1	40	101
77	772	1,631	1,249	694	654	1,935	2,629	1,562	41	1,114	695	1,073	3	41	161
78	4,862	7,943	1,622	678	1,002	2,347	3,025	2,456	2,968	914	2,749	0	37	19	38
79	3,021	5,365	2,677	784	1,021	2,566	3,350	2,529	920	1,585	2,084	665	17	25	62
80	4,940	10,270	3,121	978	1,006	2,548	3,526	2,991	1,372	626	2,830	0	13	15	34
81	2,465	4,152	2,466	978	1,020	2,523	3,501	2,309	420	1,500	1,750	1,080	10	34	84
82	8,396	16,914	5,743	784	1,007	2,289	3,073	2,862	1,887	286	3,351	0	11	7	18
83	9,018	16,059	7,967	978	1,006	2,212	3,190	3,190	750	750	3,351	0	5	0	20
84	5,493	10,887	5,547	978	1,006	2,613	3,591	3,116	685	1,783	2,253	1,098	6	13	33
85	2,710	4,390	2,317	978	1,020	2,506	3,484	2,283	1,080	1,744	1,589	664	25	34	79
86	6,181	11,376	4,102	978	1,020	2,482	3,460	2,735	1,899	770	2,718	0	17	21	30
87	1,856	3,268	2,075	978	1,019	2,688	3,666	1,936	397	1,723	1,392	1,326	12	47	112
88	2,023	3,054	1,212	694	831	2,260	2,954	1,865	596	690	1,298	94	20	37	97
89	3,330	5,434	1,914	588	1,010	2,490	3,078	1,985	1,903	1,222	1,979	0	35	36	57
90	1,969	3,453	1,529	588	1,021	2,535	3,123	1,890	586	1,441	1,124	855	17	39	90
91	1,936	3,337	1,029	588	658	1,910	2,498	2,002	723	686	1,161	0	22	20	75
92	1,687	3,286	753	588	836	2,178	2,766	1,594	686	822	1,025	136	21	42	84
93	5,372	7,742	2,959	678	1,033	2,565	3,243	2,671	2,636	1,064	2,597	0	34	18	42
94	1,821	3,025	2,120	784	829	2,266	3,050	1,827	517	1,589	1,525	1,072	17	40	101
Minimum	772	1,631	753	588	654	1,910	2,498	1,562	0	188	695	0	0	0	18
Average	3,960	6,845	2,957	859	981	2,478	3,337	2,567	1,138	1,152	2,089	395	17	23	49
Maximum	9,018	16,914	7,967	978	1,034	2,799	3,729	3,464	2,968	2,257	3,351	2,257	37	47	161

Table 9. Historic American River Water Allocation

Water Year	Unimpaired Inflow (TAF)	Estimated Diversions (TAF)	Flow at Fair Oaks (TAF)	Estimated Requirement (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Folsom Carryover Storage (TAF)	Carryover Used (TAF)	Percent of Inflow to Storage (%)	Percent of Use from Storage (%)	Percent of Inflow Used (%)
									533				
57	2,137	201	2,196	233	433	350	595	593	535	0	28	19	20
58	4,090	201	4,142	233	433	379	662	646	550	0	16	12	11
59	1,226	201	1,479	233	433	277	513	752	312	238	42	36	35
60	1,680	201	1,444	233	433	252	748	541	518	0	45	42	26
61	1,045	201	1,198	233	433	274	557	686	389	129	53	37	41
62	2,069	201	2,028	233	433	287	761	696	454	0	37	34	21
63	3,552	201	3,299	233	433	378	665	653	466	0	19	13	12
64	1,632	201	1,736	233	433	339	603	533	536	0	37	22	27
65	4,485	201	4,200	233	433	369	639	504	671	0	14	15	10
66	1,392	201	1,380	233	433	284	355	373	653	19	25	34	31
67	3,967	201	3,796	233	433	357	487	341	799	0	12	18	11
68	1,699	201	2,009	233	433	305	296	543	551	247	17	30	25
69	4,445	201	4,222	233	433	362	521	259	814	0	12	16	10
70	3,163	201	3,613	233	433	339	344	608	549	264	11	22	14
71	2,972	201	2,905	233	433	345	528	392	686	0	18	20	15
72	1,874	201	2,040	233	433	307	415	442	659	27	22	29	23
73	3,008	201	2,964	233	433	341	437	353	742	0	15	21	14
74	4,272	201	4,357	233	433	383	411	381	773	0	10	12	10
75	2,620	201	2,704	233	433	362	380	380	773	0	14	16	17
76	801	170	1,400	233	403	292	97	453	416	357	12	28	50
77	349	133	563	233	365	176	33	303	147	269	10	52	105
78	3,224	184	2,347	233	417	302	781	228	700	0	24	27	13
79	2,042	201	2,152	233	433	274	346	335	710	0	17	37	21
80	3,871	201	3,925	233	433	364	232	273	670	41	6	16	11
81	1,128	201	1,355	233	433	253	320	390	600	70	28	42	38
82	6,124	201	5,772	233	433	429	501	345	756	0	8	1	7
83	6,382	201	6,410	233	433	433	357	361	752	4	6	0	7
84	3,901	201	4,082	233	433	383	405	475	681	71	10	12	11
85	1,574	201	1,731	233	433	333	307	401	587	94	20	23	28
86	4,578	201	4,392	233	433	287	565	499	653	0	12	34	9
87	880	201	1,202	233	433	235	280	503	430	224	32	46	49
88	853	201	1,031	233	433	240	243	454	218	212	28	45	51
89	2,247	201	1,693	233	433	299	772	420	571	0	34	31	19
90	1,118	177	1,590	233	409	280	255	647	178	392	23	32	37
91	1,191	164	924	233	397	202	593	265	506	0	50	49	33
92	918	171	1,284	233	403	229	347	681	172	335	38	43	44
93	3,376	183	2,753	233	416	310	796	405	563	0	24	25	12
Minimum	349	133	563	233	365	176	33	228	147	0	6	0	7
Average	2,591	194	2,603	233	427	314	463	462	561	81	18	27	16
Maximum	6,382	201	6,410	233	433	433	796	752	814	392	53	52	105

Table 10. No-Action American River Water Allocation

Water Year	Total Runoff (TAF)	Release Flow (TAF)	Required Instream (TAF)	Total Diversions (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent of Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
									532				
22	3,367	2,960	2,176	401	2,577	2,261	582	464	650	0	17	12	77
23	2,912	2,672	1,812	401	2,213	1,876	518	580	588	62	18	15	76
24	907	1,061	910	353	1,263	836	33	435	186	402	4	34	139
25	2,545	1,988	1,168	389	1,557	1,296	886	622	450	0	35	17	61
26	1,554	1,422	1,135	401	1,536	1,088	496	660	286	164	32	29	99
27	3,762	3,090	1,633	401	2,034	1,821	689	325	650	0	18	10	54
28	2,708	2,595	1,638	401	2,039	1,639	284	469	465	185	10	20	75
29	1,303	1,251	999	353	1,352	1,060	219	422	262	203	17	22	104
30	1,730	1,441	1,066	389	1,455	1,175	562	562	262	0	32	19	84
31	1,049	916	531	283	814	810	148	211	199	63	14	0	78
32	2,388	2,025	1,037	320	1,357	1,357	663	536	326	0	28	0	57
33	1,402	1,211	739	341	1,080	1,009	235	288	273	53	17	7	77
34	1,324	1,228	559	341	900	771	392	539	126	147	30	14	68
35	2,577	1,884	1,302	389	1,691	1,535	726	329	523	0	28	9	66
36	3,495	3,061	1,918	401	2,319	2,004	610	483	650	0	17	14	66
37	2,493	2,223	1,841	401	2,242	1,646	685	721	614	36	27	27	90
38	4,631	4,289	2,267	401	2,668	2,447	483	447	650	0	10	8	58
39	1,289	1,444	1,191	401	1,592	1,105	185	628	207	443	14	31	124
40	3,454	2,769	1,216	401	1,617	1,329	743	364	586	0	22	18	47
41	3,277	2,909	1,948	401	2,349	1,972	478	414	650	0	15	16	72
42	4,048	3,743	2,221	401	2,622	2,385	434	434	650	0	11	9	65
43	4,056	3,750	1,978	401	2,379	2,072	346	346	650	0	9	13	59
44	1,632	1,690	1,487	401	1,888	1,430	219	571	298	352	13	24	116
45	2,643	2,009	1,360	401	1,761	1,471	700	374	624	0	26	16	67
46	2,979	2,699	1,811	401	2,212	1,812	435	459	600	24	15	18	74
47	1,569	1,673	1,294	401	1,695	1,271	298	699	199	401	19	25	108
48	2,321	1,563	1,317	401	1,718	1,472	765	314	650	0	33	14	74
49	1,993	1,868	1,678	401	2,079	1,475	523	695	478	172	26	29	104
50	2,775	2,294	1,765	401	2,166	1,794	667	495	650	0	24	17	78
51	4,806	4,511	1,841	401	2,242	1,855	670	682	638	12	14	17	47
52	5,063	4,745	2,267	401	2,668	2,532	400	388	650	0	8	5	53
53	2,847	2,543	1,993	401	2,394	2,180	392	392	650	0	14	9	84
54	2,175	2,007	1,639	401	2,040	1,598	310	440	520	130	14	22	94
55	1,679	1,516	1,387	401	1,788	1,438	288	422	386	134	17	20	106
56	4,684	4,111	1,904	401	2,305	2,108	878	614	650	0	19	9	49
57	2,326	2,032	1,767	401	2,168	1,701	470	479	641	9	20	22	93
58	4,181	3,867	2,267	401	2,668	2,418	450	441	650	0	11	9	64
59	1,412	1,449	1,296	401	1,697	1,204	212	540	322	328	15	29	120
60	1,765	1,386	1,144	401	1,545	1,134	592	514	400	0	34	27	88
61	1,210	1,026	901	401	1,302	978	256	365	291	109	21	25	108
62	2,063	1,525	1,197	401	1,598	1,336	568	335	524	0	28	16	77
63	3,674	3,239	1,947	401	2,348	2,035	636	510	650	0	17	13	64
64	1,756	1,864	1,487	401	1,888	1,516	140	541	249	401	8	20	108
65	4,583	3,872	1,394	401	1,795	1,586	713	312	650	0	16	12	39
66	1,567	1,531	1,425	401	1,826	1,328	262	521	391	259	17	27	117
67	3,981	3,414	2,042	401	2,443	2,306	643	384	650	0	16	6	61
68	1,851	1,831	1,425	401	1,826	1,380	170	445	375	275	9	24	99
69	4,478	3,895	2,026	401	2,427	2,258	634	359	650	0	14	7	54
70	3,447	3,307	1,608	401	2,009	1,749	367	523	494	156	11	13	58
71	3,073	2,608	1,795	401	2,196	1,945	550	394	650	0	18	11	71
72	2,008	1,914	1,608	401	2,009	1,620	273	476	447	203	14	19	100
73	3,122	2,676	1,660	401	2,061	1,649	571	432	586	0	18	20	66
74	4,452	4,081	2,101	401	2,502	2,302	534	470	650	0	12	8	56
75	2,756	2,450	2,067	401	2,468	2,121	496	496	650	0	18	14	90
76	1,156	1,369	1,160	340	1,500	1,103	68	509	209	441	6	26	130
77	453	411	313	265	578	408	26	154	81	128	6	29	128
78	2,976	2,127	1,347	368	1,715	1,482	899	330	650	0	30	14	58
79	2,214	1,980	1,723	401	2,124	1,597	537	604	583	67	24	25	96
80	3,963	3,590	1,841	401	2,242	1,923	578	511	650	0	15	14	57
81	1,351	1,386	1,281	401	1,682	1,189	180	508	322	328	13	29	125
82	6,087	5,450	1,893	401	2,294	2,194	906	578	650	0	15	4	38
83	6,479	6,173	2,267	401	2,668	2,644	508	508	650	0	8	1	41
84	4,174	3,867	1,811	401	2,212	1,952	642	642	650	0	15	12	53
85	1,768	1,876	1,456	401	1,857	1,424	288	691	247	403	16	23	105
86	4,651	3,939	1,394	401	1,795	1,532	915	512	650	0	20	15	39
87	1,153	1,329	1,130	401	1,531	1,033	128	592	186	464	11	33	133
88	1,286	842	606	401	1,007	700	535	376	345	0	42	30	78
89	2,339	1,915	1,234	401	1,635	1,383	593	473	465	0	25	15	70
90	1,308	1,269	999	353	1,352	1,081	194	410	249	216	15	20	103
91	1,444	960	825	328	1,153	971	456	228	477	0	32	16	80
92	1,026	1,147	910	341	1,251	775	252	618	111	366	25	38	122
93	3,273	2,454	1,515	366	1,881	1,692	874	335	650	0	27	10	57
94	1,040	1,261	1,086	348	1,434	978	74	546	178	472	7	32	138
Minimum	453	411	313	265	578	408	26	154	81	0	4	0	38
Average	2,675	2,390	1,493	388	1,881	1,569	468	472	477	104	17	17	70
Maximum	6,479	6,173	2,267	401	2,668	2,644	915	721	650	472	42	38	139

Table 11. Historic Delta Water Allocation for 1967-1991

Water Year	Unimapired Delta Inflow (TAF)	Total Delta Inflow (TAF)	In-Delta Diversion (TAF)	Total Delta Outflow (TAF)	D-1485 Required Outflow (TAF)	Total Delta Exports (TAF)	Total Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Storage Carryover (TAF)	Carryover Used (TAF)	Direct Delivery (TAF)	Total Delivery (TAF)	Percent of Inflow to Storage (%)	Percent of Delivery from Storage (%)	Percent of Inflow Used (%)
67	43,839	35,018	1,693	33,293	6,103	1,258	9,054	0	0	0	0	1,258	1,258	0	0	26
68	20,346	15,967	1,691	12,350	5,036	2,471	9,198	500	0	0	0	1,971	1,971	3	0	58
69	52,598	41,775	1,691	38,377	5,962	2,876	10,529	1,510	28	1,981	0	1,367	1,395	4	2	25
70	38,061	33,047	1,691	30,094	5,127	2,069	8,887	63	325	1,720	262	2,006	2,331	0	14	27
71	33,884	26,872	1,693	23,217	6,203	2,834	10,730	266	250	1,736	0	2,568	2,817	1	9	40
72	19,863	14,028	1,691	9,177	5,297	3,441	10,428	458	713	1,482	255	2,983	3,696	3	19	74
73	34,849	28,260	1,691	24,382	6,119	3,382	11,192	628	419	1,691	0	2,754	3,173	2	13	40
74	50,330	42,560	1,691	37,423	6,283	4,365	12,339	336	174	1,852	0	4,029	4,203	1	4	29
75	31,885	24,747	1,693	19,891	5,938	3,899	11,529	283	1,104	1,032	821	3,615	4,719	1	23	47
76	11,534	12,774	1,691	6,593	3,580	4,834	10,105	1,083	1,437	678	354	3,751	5,188	8	28	79
77	6,801	5,956	1,691	2,527	2,909	2,078	6,677	652	1,056	274	404	1,425	2,481	11	43	112
78	43,363	26,100	1,691	21,346	5,724	4,330	11,744	1,993	548	1,719	0	2,337	2,885	8	19	45
79	22,973	16,765	1,693	11,425	4,852	4,484	11,028	453	959	1,213	506	4,031	4,990	3	19	66
80	41,247	33,417	1,691	28,156	5,958	4,522	12,171	984	714	1,483	0	3,538	4,252	3	17	36
81	17,131	13,665	1,691	7,876	4,279	4,719	10,689	548	1,768	263	1,220	4,171	5,939	4	30	78
82	58,367	45,712	1,691	40,992	6,250	4,606	12,547	986	1,225	23	240	3,620	4,846	2	25	27
83	72,848	68,743	1,693	64,297	5,692	4,384	11,769	2,082	166	1,940	0	2,302	2,468	3	7	17
84	38,189	35,462	1,691	30,692	5,267	3,837	10,795	201	1,329	812	1,128	3,636	4,965	1	27	30
85	17,682	14,970	1,691	8,437	4,653	5,470	11,813	1,192	1,241	763	49	4,278	5,519	8	22	79
86	46,603	35,354	1,691	29,676	5,275	5,294	12,260	1,495	777	1,481	0	3,799	4,576	4	17	35
87	13,298	12,276	1,693	6,081	3,823	5,043	10,559	688	1,482	688	793	4,355	5,837	6	25	86
88	14,074	11,138	1,691	4,431	3,825	5,601	11,117	1,219	1,420	488	200	4,382	5,801	11	24	100
89	22,053	13,626	1,691	6,623	4,464	5,968	12,123	1,218	1,342	365	123	4,750	6,091	9	22	89
90	13,603	10,985	1,691	3,960	3,458	5,798	10,947	1,607	1,483	488	0	4,191	5,675	15	26	100
91	13,942	8,529	1,693	4,384	3,205	3,186	8,083	1,286	1,121	654	0	1,899	3,020	15	37	95
Minimum	6,801	5,956	1,691	2,527	2,909	1,258	6,677	0	0	0	0	1,258	1,258	0	0	17
Average	31,174	25,110	1,691	20,228	5,011	4,030	10,733	869	843	993	254	3,161	4,004	3	21	43
Maximum	72,848	68,743	1,693	64,297	6,283	5,968	12,547	2,082	1,768	1,981	1,220	4,750	6,091	15	43	112

Table 12. No-Action Delta Water Management Allocation

Water Year	Total Delta Inflow (TAF)	In-Delta Depletion (TAF)	Required Delta Outflow (TAF)	Surplus Delta Outflow (TAF)	Total Export (TAF)	Storage Increase (TAF)	Storage Release (TAF)	San Luis Carryover (TAF)	Carryover Used (TAF)	Direct Delivery (TAF)	Total Delivery (TAF)	Simulated Aqueduct Delivery (TAF)	Percent Inflow to Storage (%)	Delivery from Storage (%)	Inflow Used (%)
22	20,856	1,186	6,077	6,131	7,716	1,538	1,509	529	0	6,178	7,687	7,601	7	20	72
23	18,054	1,140	5,423	4,493	7,229	1,244	1,417	356	173	5,985	7,402	6,957	7	19	77
24	9,198	1,291	3,873	285	3,760	1,239	1,047	548	0	2,521	3,568	3,161	13	29	95
25	14,616	999	5,859	3,109	4,825	1,397	1,345	600	0	3,428	4,773	4,313	10	28	80
26	12,884	1,160	4,347	2,368	5,157	1,397	1,514	483	117	3,760	5,274	4,826	11	29	84
27	26,956	1,116	6,805	11,997	7,270	1,555	1,570	468	15	5,715	7,285	6,948	6	22	56
28	21,612	1,124	6,191	7,372	7,019	1,531	1,341	658	0	5,488	6,829	6,350	7	20	65
29	10,019	1,170	3,824	530	4,518	1,380	1,274	764	0	3,138	4,412	3,984	14	29	94
30	12,517	1,175	4,653	1,555	5,266	1,274	1,265	773	0	3,992	5,257	4,807	10	24	89
31	8,382	1,216	3,739	71	3,404	787	1,219	341	432	2,617	3,836	3,420	9	32	105
32	12,179	1,176	4,995	1,152	5,132	1,552	1,110	783	0	3,580	4,690	4,232	13	24	89
33	8,789	1,226	3,837	275	3,531	1,055	1,247	591	192	2,476	3,723	3,271	12	33	100
34	9,801	1,221	4,424	265	3,988	1,206	1,356	441	150	2,782	4,138	3,684	12	33	100
35	16,480	1,080	6,140	3,558	5,900	1,427	1,633	235	206	4,473	6,106	5,812	9	27	81
36	19,896	1,169	5,974	5,904	7,175	1,577	1,495	317	0	5,598	7,093	6,693	8	21	72
37	17,911	1,183	5,593	4,901	6,639	1,721	1,597	441	0	4,918	6,515	6,463	10	25	74
38	46,039	1,116	7,493	30,065	7,853	1,607	1,029	1,019	0	6,246	7,275	7,661	3	14	35
39	14,105	1,235	3,955	2,759	6,169	1,019	1,289	749	270	5,150	6,439	5,994	7	20	82
40	25,036	1,189	7,304	10,722	6,321	1,384	1,856	277	472	4,937	6,793	6,542	6	27	61
41	39,811	1,042	7,124	23,947	8,190	1,560	1,169	668	0	6,630	7,799	7,596	4	15	40
42	35,554	1,037	6,746	20,016	8,003	1,210	1,169	709	0	6,793	7,962	7,740	3	15	44
43	29,022	1,134	7,368	13,567	7,174	1,300	1,257	752	0	5,874	7,131	7,023	4	18	54
44	14,318	1,209	4,198	2,327	6,711	1,310	1,562	500	252	5,401	6,963	6,549	9	22	86
45	16,206	1,138	4,847	3,398	6,958	1,537	1,581	456	44	5,421	7,002	6,647	9	23	80
46	21,114	1,169	5,918	6,898	7,193	1,483	1,588	351	105	5,710	7,298	6,901	7	22	68
47	13,151	1,207	4,424	1,073	6,465	1,681	1,508	524	0	4,784	6,292	5,865	13	24	91
48	13,811	1,113	4,620	2,359	5,726	1,002	1,262	264	260	4,724	5,986	5,586	7	21	85
49	14,585	1,204	4,269	2,496	6,680	1,766	1,558	472	0	4,914	6,472	6,047	12	24	82
50	14,982	1,229	5,004	2,280	6,563	1,581	1,423	630	0	4,982	6,405	5,978	11	22	84
51	30,083	1,095	6,113	15,880	7,240	1,412	1,495	547	83	5,828	7,323	6,957	5	20	48
52	37,738	1,093	7,770	21,215	8,062	1,504	986	1,065	0	6,558	7,544	7,710	4	13	43
53	25,236	1,181	5,800	10,988	7,394	1,063	1,280	848	217	6,331	7,611	7,168	4	17	58
54	21,794	1,204	6,813	6,713	7,079	1,190	1,466	572	276	5,889	7,355	6,939	5	20	71
55	13,368	1,150	4,153	2,324	5,848	1,332	1,295	609	0	4,516	5,811	5,382	10	22	83
56	37,656	1,149	6,591	22,877	7,478	1,439	1,371	677	0	6,039	7,410	7,347	4	19	40
57	17,591	1,143	5,156	4,264	7,056	1,244	1,183	738	0	5,812	6,995	6,541	7	17	76
58	41,308	1,054	6,761	26,182	7,879	1,299	1,027	1,010	0	6,580	7,607	7,586	3	14	37
59	17,527	1,256	5,128	4,559	6,682	1,041	1,527	524	486	5,641	7,168	6,701	6	21	77
60	12,464	1,248	4,472	1,143	5,686	1,514	1,596	442	82	4,172	5,768	5,349	12	28	92
61	13,094	1,199	4,403	1,461	6,112	1,596	1,324	714	0	4,516	5,840	5,410	12	23	87
62	15,590	1,248	5,910	2,632	6,031	1,366	1,949	131	583	4,665	6,614	6,255	9	29	88
63	26,880	1,019	6,844	11,606	7,643	1,700	1,164	667	0	5,943	7,107	6,828	6	16	56
64	14,124	1,265	4,210	2,328	6,383	1,225	1,490	402	265	5,158	6,648	6,180	9	22	86
65	28,774	1,121	6,725	14,072	7,021	1,734	1,377	759	0	5,287	6,664	6,249	6	21	50
66	17,225	1,211	4,719	4,481	6,898	1,191	1,681	269	490	5,707	7,388	6,986	7	23	77
67	31,493	1,042	7,759	14,908	8,184	1,771	780	1,260	0	6,413	7,193	7,589	6	11	51
68	18,906	1,194	5,622	5,556	6,606	778	1,483	555	705	5,828	7,311	6,873	4	20	75
69	40,308	1,193	7,584	24,407	7,604	1,499	1,000	1,054	0	6,105	7,105	7,656	4	14	39
70	35,304	1,196	5,519	21,906	6,955	995	1,616	433	621	5,960	7,576	7,226	3	21	40
71	24,777	1,126	6,848	9,250	7,690	1,531	1,236	728	0	6,159	7,395	7,021	6	17	62
72	14,968	1,270	4,783	2,228	6,700	1,310	1,365	673	55	5,390	6,755	6,308	9	20	86
73	27,200	1,082	6,772	12,719	7,165	1,370	1,316	727	0	5,795	7,111	6,758	5	19	55
74	41,333	1,044	6,803	25,789	7,868	1,322	1,406	643	84	6,546	7,952	7,676	3	18	38
75	25,491	1,165	6,695	9,944	7,838	1,212	1,225	630	13	6,626	7,851	7,446	5	16	62
76	12,914	1,298	3,680	1,888	6,049	1,224	998	856	0	4,825	5,823	5,400	9	17	84
77	7,601	1,242	3,943	0	2,420	380	725	511	345	2,040	2,765	2,328	5	26	105
78	24,466	1,102	7,244	10,215	6,416	1,527	1,470	568	0	4,889	6,359	6,713	6	23	60
79	17,905	1,215	5,786	3,953	7,218	1,302	1,281	589	0	5,916	7,197	6,716	7	18	79
80	30,814	1,111	6,560	16,583	6,918	1,583	1,097	1,075	0	5,335	6,432	6,673	5	17	46
81	15,577	1,225	4,723	3,276	6,416	963	1,458	580	495	5,453	6,911	6,493	6	21	83
82	45,250	973	7,016	29,906	7,843	1,466	1,120	926	0	6,377	7,497	7,577	3	15	34
83	67,571	965	6,503	53,171	7,753	1,238	516	1,648	0	6,515	7,031	8,141	2	7	21
84	35,520	1,165	6,016	21,957	6,510	390	1,629	409	1,239	6,120	7,749	7,655	1	21	42
85	15,098	1,092	4,370	3,032	6,670	1,391	1,575	225	184	5,279	6,854	6,453	9	23	82
86	34,560	1,104	6,000	21,235	6,732	1,947	1,039	1,133	0	4,785	5,824	5,896	6	18	37
87	12,981	1,242	4,249	1,969	5,570	905	1,443	595	538	4,665	6,108	5,683	7	24	89
88	10,385	1,174	4,098	956	4,244	1,075	1,064	606	0	3,169	4,233	3,842	10	25	92
89	12,881	1,163	4,369	2,194	5,171	1,403	1,511	498	108	3,768	5,279	4,881	11	29	84
90	11,163	1,174	4,065	774	5,193	1,292	1,058	732	0	3,901	4,959	4,503	12	21	91
91	9,548	1,159	4,027	1,198	3,214	742	701	773	0	2,472	3,173	2,715	8	22	88
92	10,619	1,155	4,341	1,414	3,853	1,265	1,206	832	0	2,588	3,794	3,327	12	32	87
93	23,710	1,063	8,240	7,922	7,124	1,202	1,461	573	259	5,922	7,383	7,128	5	20	70
94	12,914	1,200	4,022	1,257	6,526	1,197	1,253	517	56	5,329	6,582	6,140	9	19	91
Minimum	7,601	965	3,680	0	2,420	380	516	131	0	2,040	2,765	2,328	1	7	21
Average	21,638	1,156	5,537	8,743	6,404	1,321	1,321	630	135	5,083	6,404	6,124	6	21	61
Maximum	67,571	1,298	8,240	53,171	8,190	1,947	1,949	1,648	1,239	6,793	7,962	8,141	14	33	105

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Table 13. No-Action Potential for Additional Delta Exports

Water Year	Total Export (TAF)	Direct Delivery (TAF)	Total Delivery (TAF)	Surplus Delta Outflow (TAF)	Additional Needed for Target Delta Outflow (TAF)	Maximum Export Based on Outflow (TAF)	Maximum Export Based on Inflow (TAF)	Unused Permitted Capacity (TAF)	Potential Additional Exports with Permitted Capacity (TAF)	Unused Physical Capacity (TAF)	Potential Additional Exports with Physical Capacity (TAF)
22	7,716	6,178	7,687	6,131	33	13,847	9,001	565	333	2,951	1,620
23	7,229	5,985	7,402	4,493	212	11,722	9,348	1,073	506	3,438	1,313
24	3,760	2,521	3,568	285	1,574	4,045	4,840	4,287	105	6,907	285
25	4,825	3,428	4,773	3,109	667	7,934	6,904	3,240	384	5,842	782
26	5,157	3,760	5,274	2,368	639	7,525	6,327	2,971	391	5,510	949
27	7,270	5,715	7,285	11,997	126	19,267	11,360	849	454	3,397	1,696
28	7,019	5,488	6,829	7,372	371	14,391	9,894	1,235	213	3,648	1,199
29	4,518	3,138	4,412	530	1,420	5,048	5,213	3,561	214	6,149	530
30	5,266	3,992	5,257	1,555	649	6,821	6,209	2,847	238	5,401	741
31	3,404	2,617	3,836	71	1,900	3,475	4,349	4,643	71	7,263	71
32	5,132	3,580	4,690	1,152	427	6,284	6,185	3,041	0	5,535	519
33	3,531	2,476	3,723	275	1,597	3,806	4,506	4,516	185	7,136	275
34	3,988	2,782	4,138	265	1,065	4,253	4,884	4,094	64	6,679	265
35	5,900	4,473	6,106	3,558	132	9,458	7,113	2,245	150	4,767	713
36	7,175	5,598	7,093	5,904	197	13,079	9,334	1,050	379	3,492	996
37	6,639	4,918	6,515	4,901	283	11,540	8,542	1,578	256	4,028	947
38	7,853	6,246	7,275	30,065	0	37,918	18,213	438	98	2,814	1,807
39	6,169	5,150	6,439	2,759	831	8,928	7,622	1,971	310	4,498	1,520
40	6,321	4,937	6,793	10,722	277	17,043	9,812	2,015	177	4,346	772
41	8,190	6,630	7,799	23,947	0	32,137	16,961	195	76	2,477	1,332
42	8,003	6,793	7,962	20,016	0	28,019	16,326	333	316	2,664	2,140
43	7,174	5,874	7,131	13,567	286	20,741	13,985	1,046	188	3,493	1,538
44	6,711	5,401	6,963	2,327	752	9,038	7,277	1,386	305	3,956	1,148
45	6,958	5,421	7,002	3,398	659	10,356	8,179	1,274	303	3,709	885
46	7,193	5,710	7,298	6,898	274	14,091	11,537	1,089	167	3,474	905
47	6,465	4,784	6,292	1,073	1,045	7,538	6,881	1,727	142	4,202	754
48	5,726	4,724	5,986	2,359	450	8,085	6,276	2,321	837	4,941	1,608
49	6,680	4,914	6,472	2,496	817	9,176	7,290	1,427	280	3,987	752
50	6,563	4,982	6,405	2,280	243	8,843	7,267	1,599	415	4,104	1,057
51	7,240	5,828	7,323	15,880	340	23,120	16,261	1,020	266	3,427	1,389
52	8,062	6,558	7,544	21,215	0	29,277	15,980	263	53	2,605	1,696
53	7,394	6,331	7,611	10,988	0	18,382	13,451	717	701	3,273	2,588
54	7,079	5,889	7,355	6,713	348	13,792	9,689	1,026	339	3,588	1,579
55	5,848	4,516	5,811	2,324	817	8,172	7,269	2,276	471	4,819	1,054
56	7,478	6,039	7,410	22,877	0	30,355	19,435	808	499	3,189	1,887
57	7,056	5,812	6,995	4,264	327	11,320	8,377	1,124	372	3,611	1,424
58	7,879	6,580	7,607	26,182	0	34,061	15,587	306	196	2,788	2,280
59	6,682	5,641	7,168	4,559	808	11,241	8,977	1,457	118	3,985	890
60	5,686	4,172	5,768	1,143	992	6,829	6,300	2,434	162	4,981	533
61	6,112	4,516	5,840	1,461	1,044	7,573	6,795	2,032	210	4,555	728
62	6,031	4,665	6,614	2,632	743	8,663	7,680	2,166	0	4,636	202
63	7,643	5,943	7,107	11,606	132	19,249	10,761	639	359	3,024	1,956
64	6,383	5,158	6,648	2,328	986	8,711	7,674	1,786	291	4,284	928
65	7,021	5,287	6,664	14,072	143	21,093	14,821	1,306	321	3,646	909
66	6,898	5,707	7,388	4,481	509	11,379	8,997	1,257	181	3,769	1,341
67	8,184	6,413	7,193	14,908	0	23,092	13,520	128	35	2,483	1,945
68	6,606	5,828	7,311	5,556	636	12,162	9,355	1,524	363	4,061	1,528
69	7,604	6,105	7,105	24,407	0	32,011	17,766	625	277	3,063	1,851
70	6,955	5,960	7,576	21,906	476	28,861	19,299	1,190	508	3,712	1,836
71	7,690	6,159	7,395	9,250	0	16,940	12,520	597	277	2,977	1,665
72	6,700	5,390	6,755	2,228	729	8,928	7,683	1,456	174	3,967	1,249
73	7,165	5,795	7,111	12,719	72	19,884	13,263	936	436	3,502	1,466
74	7,868	6,546	7,952	25,789	0	33,657	20,033	360	360	2,799	2,274
75	7,838	6,626	7,851	9,944	136	17,782	11,347	425	343	2,829	2,321
76	6,049	4,825	5,823	1,888	1,237	7,937	6,927	2,085	315	4,618	1,358
77	2,420	2,040	2,765	0	1,733	2,420	3,939	5,627	0	8,247	0
78	6,416	4,889	6,359	10,215	92	16,631	10,933	1,729	328	4,251	1,295
79	7,218	5,916	7,197	3,953	147	11,171	8,660	1,073	267	3,449	936
80	6,918	5,335	6,432	16,583	62	23,501	14,856	1,221	748	3,749	1,818
81	6,416	5,453	6,911	3,276	666	9,692	7,855	1,696	438	4,251	1,402
82	7,843	6,377	7,497	29,906	0	37,749	18,942	436	150	2,824	1,871
83	7,753	6,515	7,031	53,171	0	60,924	28,715	439	439	2,914	2,914
84	6,510	6,120	7,749	21,957	258	28,467	20,180	1,573	1,029	4,157	2,334
85	6,670	5,279	6,854	3,032	880	9,702	8,083	1,492	338	3,997	1,293
86	6,732	4,785	5,824	21,235	114	27,967	14,219	1,559	372	3,935	1,214
87	5,570	4,665	6,108	1,969	897	7,539	6,664	2,497	657	5,097	1,309
88	4,244	3,169	4,233	956	1,231	5,200	5,423	3,852	34	6,423	370
89	5,171	3,768	5,279	2,194	1,005	7,365	6,074	2,931	371	5,496	785
90	5,193	3,901	4,959	774	972	5,967	5,783	2,868	265	5,474	488
91	3,214	2,472	3,173	1,198	1,190	4,412	4,560	4,871	106	7,453	291
92	3,853	2,588	3,794	1,414	1,234	5,267	5,061	4,194	318	6,814	629
93	7,124	5,922	7,383	7,922	0	15,046	11,181	1,165	355	3,543	1,571
94	6,526	5,329	6,582	1,257	1,260	7,783	6,850	1,663	18	4,141	629
Minimum	2,420	2,040	2,765	0	0	2,420	3,939	128	0	2,477	0
Average	6,404	5,083	6,404	8,743	536	15,146	10,265	1,773	293	4,264	1,221
Maximum	8,190	6,793	7,962	53,171	1,900	60,924	28,715	5,627	1,029	8,247	2,914

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Table 14. Annual Aqueduct Deliveries (CVP+SWP) as Simulated by DWRSIM for the CALFED Alternatives

Water Year	No-Action (TAF)	Alt 1 or Alt 2 472B (TAF)	Alt 1 or Alt 2 510 (TAF)	Alt 3 475 (TAF)	Alt 3 500 (TAF)
22	7,601	7,714	7,590	7,863	7,607
23	6,957	7,190	6,956	7,352	7,134
24	3,161	3,190	5,587	3,481	5,649
25	4,313	4,827	6,177	5,132	6,667
26	4,826	5,128	5,999	5,328	6,355
27	6,948	7,078	7,023	7,157	7,102
28	6,350	6,841	7,027	7,013	7,093
29	3,984	3,901	6,103	4,170	6,143
30	4,807	4,914	6,078	5,009	6,501
31	3,420	3,369	4,201	3,415	4,594
32	4,232	4,390	4,509	4,371	4,945
33	3,271	3,308	3,342	3,429	3,681
34	3,684	3,839	3,680	3,973	3,897
35	5,812	6,091	5,872	5,999	5,979
36	6,693	7,115	7,161	7,104	7,208
37	6,463	6,731	7,169	6,730	7,161
38	7,661	7,961	7,574	7,920	7,597
39	5,994	6,153	7,084	6,220	7,182
40	6,542	6,689	6,775	6,643	6,621
41	7,596	7,865	7,522	7,869	7,485
42	7,740	7,916	7,789	8,098	7,854
43	7,023	7,287	7,513	7,324	7,612
44	6,549	6,635	6,817	6,675	6,901
45	6,647	6,865	6,986	6,838	7,064
46	6,901	7,117	7,012	7,181	7,040
47	5,865	5,990	6,740	6,120	6,895
48	5,586	5,603	6,497	6,088	6,717
49	6,047	6,191	7,043	6,600	7,087
50	5,978	6,272	6,899	6,419	6,972
51	6,957	7,112	7,060	7,241	7,154
52	7,710	7,943	7,615	7,988	7,579
53	7,168	7,477	7,578	7,591	7,531
54	6,939	7,172	7,267	7,396	7,547
55	5,382	5,634	6,828	5,812	6,921
56	7,347	7,422	7,506	7,584	7,520
57	6,541	6,771	7,031	6,874	7,273
58	7,586	7,802	7,660	7,871	7,563
59	6,701	6,986	7,261	7,004	7,284
60	5,349	5,413	6,556	5,431	6,667
61	5,410	5,389	6,632	5,383	6,655
62	6,255	6,495	6,920	6,483	7,095
63	6,828	7,225	7,150	7,425	7,108
64	6,180	6,654	6,924	6,879	7,028
65	6,249	6,538	7,107	6,589	7,099
66	6,986	7,145	7,066	7,299	7,081
67	7,589	7,933	7,573	7,971	7,550
68	6,873	7,114	7,454	7,112	7,456
69	7,656	7,845	7,524	7,843	7,535
70	7,226	7,458	7,584	7,459	7,564
71	7,021	7,145	7,049	7,226	7,074
72	6,308	6,607	7,075	6,702	7,135
73	6,758	6,929	7,025	7,101	7,136
74	7,676	7,834	7,591	7,970	7,598
75	7,446	7,738	7,661	7,882	7,780
76	5,400	5,671	6,376	5,767	6,510
77	2,328	2,375	5,026	2,366	5,025
78	6,713	6,798	7,101	6,861	7,002
79	6,716	6,838	6,941	6,928	7,126
80	6,673	6,755	7,113	6,899	7,147
81	6,493	6,624	7,045	6,656	7,153
82	7,577	7,787	7,531	7,788	7,531
83	8,141	8,426	8,265	8,425	8,255
84	7,655	7,760	7,770	7,760	7,770
85	6,453	6,894	6,827	7,123	6,927
86	5,896	6,353	6,642	6,475	6,806
87	5,683	5,797	6,645	5,905	6,681
88	3,842	4,034	6,222	4,141	6,269
89	4,881	5,100	5,935	5,151	6,088
90	4,503	4,607	5,267	4,766	5,635
91	2,715	2,765	3,126	2,837	3,461
92	3,327	3,461	3,837	3,433	3,990
93	7,128	7,152	7,032	7,155	7,004
94	6,140	6,407	6,438	6,428	6,591
Minimum	2,328	2,375	3,126	2,366	3,461
Average	6,124	6,323	6,693	6,418	6,790
Maximum	8,141	8,426	8,265	8,425	8,255

Table 15. Historic Stanislaus River Water Allocation

Water Year	Unimpaired Inflow (TAF)	Estimated Inflow (TAF)	Flow Below Goodwin (TAF)	Estimated Requirement (TAF)	Total Diversion (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	New Melones Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Inflow Used (%)
57	894	687	163	200	524	724	560	10	11	1	0	2	23	105
58	1,678	1,552	998	260	555	815	751	13	13	1	0	1	8	52
59	584	633	119	200	514	714	593	4	4	1	0	1	17	113
60	594	530	7	154	523	677	530	9	10	0	1	2	22	128
61	404	428	17	154	400	554	370	97	86	11	0	23	33	129
62	995	916	319	154	597	751	576	115	115	11	0	13	23	82
63	1,268	1,244	731	154	513	667	520	109	110	11	0	9	22	54
64	643	667	115	154	552	706	510	112	113	10	1	17	28	106
65	1,757	1,682	1,101	154	568	722	592	107	95	23	0	6	18	43
66	703	773	272	154	516	670	500	124	139	7	16	16	25	87
67	1,932	1,742	1,212	260	522	782	659	146	138	16	0	8	16	45
68	640	670	158	200	517	717	523	113	117	11	5	17	27	107
69	2,211	2,118	1,543	260	574	834	709	175	175	12	0	8	15	39
70	1,320	1,320	722	213	596	809	635	109	107	13	0	8	22	61
71	1,074	1,028	405	164	623	787	636	118	119	12	1	12	19	77
72	776	776	188	154	589	743	574	111	112	11	1	14	23	96
73	1,281	1,225	676	154	549	703	559	157	156	11	0	13	20	57
74	1,560	1,454	903	260	552	812	658	159	160	10	1	11	19	56
75	1,242	1,223	585	306	636	942	743	108	106	12	0	9	21	77
76	371	502	103	200	407	607	443	49	57	3	8	10	27	121
77	155	127	5	154	123	277	127	4	4	3	0	3	54	218
78	1,590	1,405	855	154	509	663	543	150	110	44	0	11	18	47
79	1,164	1,122	431	165	618	783	554	253	181	116	0	23	29	70
80	1,804	1,777	1,010	270	606	876	779	398	237	277	0	22	11	49
81	591	607	173	200	587	787	489	152	305	124	153	25	38	130
82	2,345	2,243	506	260	504	764	639	1,512	278	1,358	0	67	16	34
83	2,952	2,914	1,678	306	570	876	794	1,156	489	2,024	0	40	9	30
84	1,434	1,570	1,066	227	687	914	678	243	426	1,841	183	16	26	58
85	678	677	454	164	557	721	445	114	448	1,508	333	17	38	106
86	1,936	1,837	857	260	540	800	618	746	306	1,948	0	41	23	44
87	372	402	448	200	458	658	336	6	511	1,443	505	2	49	164
88	378	338	408	154	384	538	297	24	477	989	454	7	45	159
89	778	559	389	154	487	641	409	65	383	672	317	12	36	115
90	469	471	269	154	496	650	314	128	422	378	294	27	52	138
91	511	527	134	154	475	629	445	90	172	296	81	17	29	119
92	486	454	187	154	479	633	302	133	346	84	212	29	52	139
93	1,592	1,278	289	154	403	557	425	714	127	671	0	56	24	44
Minimum	155	127	5	154	123	277	127	4	4	0	0	1	8	30
Average	1,113	1,067	527	194	522	716	536	212	194	377	69	20	25	67
Maximum	2,952	2,914	1,678	306	687	942	794	1,512	511	2,024	505	67	54	218

Table 16. No-Action Stanislaus River Water Allocation

Water Year	Total Runoff (TAF)	Downstream Flow (TAF)	Fish Flow Required (TAF)	Total Diversions (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
									999				
22	1,581	438	154	803	957	746	639	320	1,318	0	40	22	61
23	1,291	464	154	808	962	749	316	319	1,315	3	24	22	75
24	536	360	154	526	680	399	102	467	950	365	19	41	127
25	1,268	367	154	648	802	664	463	229	1,184	0	37	17	63
26	779	423	154	654	808	532	160	471	873	311	21	34	104
27	1,436	434	154	654	808	659	559	231	1,201	0	39	18	56
28	1,126	428	154	654	808	572	401	378	1,224	0	36	29	72
29	661	347	154	595	749	519	100	395	929	295	15	31	113
30	827	334	154	651	805	602	171	342	758	171	21	25	97
31	585	321	154	552	706	441	106	405	459	299	18	38	121
32	1,326	303	154	649	803	675	573	214	818	0	43	16	61
33	740	330	154	646	800	583	102	347	573	245	14	27	108
34	655	324	154	589	743	439	175	441	307	266	27	41	113
35	1,256	285	154	651	805	643	547	238	616	0	44	20	64
36	1,495	345	154	654	808	648	718	240	1,094	0	48	20	54
37	1,275	296	154	654	808	636	547	244	1,397	0	43	21	63
38	2,254	623	260	801	1,061	902	1,023	221	2,199	0	45	15	47
39	716	714	200	785	985	576	30	833	1,396	803	4	42	138
40	1,513	386	160	807	967	720	664	368	1,692	0	44	26	64
41	1,478	385	264	810	1,074	835	579	322	1,949	0	39	22	73
42	1,637	640	306	810	1,116	939	405	244	2,110	0	25	16	68
43	1,742	1,087	306	810	1,116	899	247	428	1,929	181	14	19	64
44	811	394	200	810	1,010	668	102	515	1,516	413	13	34	125
45	1,406	325	167	810	977	763	554	306	1,764	0	39	22	69
46	1,346	530	266	810	1,076	836	353	370	1,747	17	26	22	80
47	788	484	199	663	862	597	141	519	1,369	378	18	31	109
48	1,014	403	154	654	808	661	188	247	1,310	59	19	18	80
49	896	407	154	654	808	631	176	360	1,126	184	20	22	90
50	1,198	420	154	654	808	652	366	262	1,230	0	31	19	67
51	1,862	797	160	801	961	681	820	578	1,472	0	44	29	52
52	2,060	482	264	810	1,074	930	960	220	2,212	0	47	13	52
53	1,130	946	213	810	1,023	808	63	711	1,564	648	6	21	91
54	1,044	444	164	810	974	665	228	457	1,335	229	22	32	93
55	821	394	154	662	816	610	169	421	1,083	252	21	25	99
56	2,035	505	260	801	1,061	877	1,053	349	1,787	0	52	17	52
57	1,038	522	200	810	1,010	720	190	503	1,474	313	18	29	97
58	1,816	401	260	810	1,070	848	891	310	2,055	0	49	21	59
59	783	676	200	810	1,010	579	41	765	1,331	724	5	43	129
60	728	354	154	646	800	528	169	459	1,041	290	23	34	110
61	592	345	154	557	711	445	117	437	721	320	20	37	120
62	1,031	339	154	649	803	638	285	251	755	0	28	21	78
63	1,406	337	154	654	808	669	605	211	1,149	0	43	17	57
64	791	386	154	654	808	563	179	442	886	263	23	30	102
65	1,868	494	154	801	955	779	810	260	1,436	0	43	18	51
66	892	459	154	663	817	558	249	495	1,190	246	28	32	92
67	2,039	389	260	801	1,061	926	1,010	186	2,014	0	50	13	52
68	828	674	200	810	1,010	610	49	722	1,341	673	6	40	122
69	2,313	650	260	809	1,069	878	1,092	267	2,166	0	47	18	46
70	1,510	1,317	213	810	1,023	759	69	708	1,527	639	5	26	68
71	1,239	529	164	810	974	754	318	439	1,406	121	26	23	79
72	925	544	154	662	816	567	196	494	1,108	298	21	31	88
73	1,434	329	154	654	808	633	688	258	1,538	0	48	22	56
74	1,691	503	260	801	1,061	835	673	311	1,900	0	40	21	63
75	1,388	636	306	810	1,116	852	298	381	1,817	83	21	24	80
76	617	413	200	577	777	467	121	517	1,421	396	20	40	126
77	415	373	154	440	594	345	31	444	1,008	413	7	42	143
78	1,504	274	154	645	799	711	719	158	1,569	0	48	11	53
79	1,328	402	165	801	966	686	507	403	1,673	0	38	29	73
80	1,922	773	270	810	1,080	919	542	228	1,987	0	28	15	56
81	792	612	200	810	1,010	597	41	690	1,338	649	5	41	128
82	2,425	705	260	810	1,070	934	1,093	210	2,221	0	45	13	44
83	3,117	2,226	306	810	1,116	1,050	450	398	2,273	0	14	6	36
84	1,825	1,727	227	810	1,037	831	69	803	1,539	734	4	20	57
85	904	415	164	663	827	615	237	430	1,346	193	26	26	91
86	2,044	694	260	801	1,061	863	807	280	1,873	0	39	19	52
87	646	402	200	598	798	521	97	470	1,500	373	15	35	124
88	544	396	154	517	671	454	55	440	1,115	385	10	32	123
89	793	348	154	648	802	637	126	344	897	218	16	21	101
90	647	340	154	586	740	444	156	445	608	289	24	40	114
91	673	320	154	589	743	551	90	335	363	245	13	26	110
92	637	325	154	561	715	431	162	419	106	257	25	40	112
93	2,043	610	154	654	808	684	1,042	276	872	0	51	15	40
94	676	327	154	589	743	551	91	341	622	250	13	26	110
Minimum	415	274	154	440	594	345	30	158	106	0	4	6	36
Average	1,239	517	189	708	897	674	386	391	1,329	185	31	25	72
Maximum	3,117	2,226	306	810	1,116	1,050	1,093	833	2,273	803	52	43	143

Table 17. Historic Tuolumne River Water Allocation

Water Year	Unimpaired Inflow (TAF)	Estimated Inflow (TAF)	Flow at La Grange (TAF)	Estimated Requirement (TAF)	Total Diversion (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Don Pedro Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Inflow Used (%)
72	1,207	1,014	165	129	852	981	711	253	255	362	2	25	27	97
73	2,031	1,643	165	239	928	1,167	860	828	278	913	0	50	26	71
74	2,239	1,903	376	299	979	1,278	998	887	339	1,461	0	47	22	67
75	2,033	1,778	561	299	1,081	1,380	1,113	590	454	1,597	0	33	19	78
76	671	623	361	163	1,172	1,335	612	0	910	687	910	0	54	214
77	383	124	67	93	437	530	124	1	381	307	380	1	77	426
78	2,903	2,362	292	238	802	1,040	929	1,361	93	1,575	0	58	11	44
79	1,914	1,717	657	299	1,028	1,327	1,020	370	338	1,606	0	22	23	77
80	3,045	2,719	1,507	299	1,074	1,373	1,215	533	396	1,744	0	20	12	51
81	1,056	936	441	190	1,118	1,308	821	13	638	1,119	624	1	37	140
82	3,806	3,272	1,718	253	926	1,179	1,077	886	258	1,747	0	27	9	36
83	4,631	4,436	3,465	299	1,013	1,312	1,275	812	855	1,705	42	18	3	30
84	2,471	2,388	1,386	299	1,194	1,493	1,139	618	811	1,512	193	26	24	63
85	1,229	1,055	376	188	978	1,166	779	87	386	1,213	299	8	33	111
86	2,971	2,529	1,134	239	935	1,174	993	780	321	1,672	0	31	15	46
87	656	445	283	163	900	1,063	405	5	744	934	739	1	62	239
88	821	628	78	102	553	655	448	205	208	930	3	33	32	104
89	1,312	886	61	115	684	799	571	357	217	1,071	0	40	29	90
90	843	738	85	103	732	835	501	226	305	992	79	31	40	113
91	1,099	783	83	102	746	848	605	187	232	947	45	24	29	108
92	835	670	81	102	760	862	452	226	395	777	170	34	47	128
Minimum	383	124	61	93	437	530	124	0	93	307	0	0	3	30
Average	1,817	1,555	635	201	900	1,100	793	439	420	1,184	166	28	28	71
Maximum	4,631	4,436	3,465	299	1,194	1,493	1,275	1,361	910	1,747	910	58	77	426

Table 18. No-Action Tuolomne River Water Allocation

Water Year	Total Runoff (TAF)	Downstream Flow (TAF)	Fish Flow Required (TAF)	Total Diversions (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
									328				
22	2,231	302	299	1,015	1,314	960	1,250	346	1,232	0	56	27	59
23	1,550	323	299	1,015	1,314	984	510	371	1,371	0	33	25	85
24	392	166	154	744	898	380	11	587	795	576	3	58	229
25	1,509	189	153	915	1,068	746	710	366	1,139	0	47	30	71
26	952	186	141	877	1,018	565	337	507	969	170	35	44	107
27	1,727	302	239	986	1,225	896	763	393	1,339	0	44	27	71
28	1,340	203	190	965	1,155	740	554	458	1,435	0	41	36	86
29	705	144	130	747	877	519	151	402	1,184	251	21	41	124
30	864	141	116	694	810	545	279	314	1,149	35	32	33	94
31	368	128	94	694	788	325	40	546	643	506	11	59	214
32	1,772	288	238	965	1,203	908	786	328	1,101	0	44	25	68
33	837	244	190	874	1,064	601	212	544	769	332	25	44	127
34	611	147	108	715	823	442	164	458	475	294	27	46	135
35	1,738	251	238	965	1,203	839	875	408	942	0	50	30	69
36	1,918	320	299	1,015	1,314	885	981	471	1,452	0	51	33	69
37	1,765	479	299	1,015	1,314	819	731	542	1,641	0	41	38	74
38	3,181	1,951	299	1,015	1,314	1,005	494	362	1,773	0	16	24	41
39	842	305	188	874	1,062	688	54	467	1,360	413	6	35	126
40	1,902	616	239	986	1,225	798	697	477	1,580	0	37	35	64
41	2,277	984	299	1,015	1,314	1,016	525	333	1,772	0	23	23	58
42	2,162	1,064	299	1,015	1,314	1,007	361	361	1,772	0	17	23	61
43	2,158	1,144	299	1,015	1,314	954	341	425	1,688	84	16	27	61
44	1,032	214	214	965	1,179	720	279	502	1,465	223	27	39	114
45	1,825	510	252	1,018	1,270	927	605	387	1,683	0	33	27	70
46	1,656	858	299	1,015	1,314	897	162	457	1,388	295	10	32	79
47	888	192	188	874	1,062	648	221	466	1,143	245	25	39	120
48	1,061	177	154	936	1,090	707	316	430	1,029	114	30	35	103
49	975	168	143	968	1,111	605	328	540	817	212	34	46	114
50	1,266	210	168	968	1,136	654	555	519	853	0	44	42	90
51	2,314	786	252	1,018	1,270	841	924	486	1,291	0	40	34	55
52	2,687	1,107	299	1,015	1,314	1,031	815	333	1,773	0	30	22	49
53	1,325	495	214	965	1,179	823	209	423	1,559	214	16	30	89
54	1,183	211	167	968	1,135	654	451	526	1,484	75	38	42	96
55	899	158	141	877	1,018	615	250	457	1,277	207	28	40	113
56	2,856	1,290	239	986	1,225	931	837	341	1,773	0	29	24	43
57	1,181	312	214	965	1,179	724	354	531	1,596	177	30	39	100
58	2,388	1,113	252	1,018	1,270	948	552	375	1,773	0	23	25	53
59	834	326	188	874	1,062	580	129	570	1,332	441	15	45	127
60	790	111	103	715	818	535	222	327	1,227	105	28	35	104
61	416	124	93	694	787	377	35	493	769	458	8	52	189
62	1,486	195	153	915	1,068	759	660	342	1,087	0	44	29	72
63	1,792	321	252	1,018	1,270	922	787	402	1,472	0	44	27	71
64	930	221	188	874	1,062	724	174	411	1,235	237	19	32	114
65	2,403	802	239	986	1,225	1,017	782	249	1,768	0	33	17	51
66	1,227	740	190	965	1,155	676	9	560	1,217	551	1	41	94
67	2,723	1,066	253	1,018	1,271	1,012	881	325	1,773	0	32	20	47
68	870	285	188	874	1,062	631	144	510	1,407	366	17	41	122
69	3,529	2,095	239	986	1,225	973	674	308	1,773	0	19	21	35
70	1,763	1,041	299	1,015	1,314	946	91	461	1,403	370	5	28	75
71	1,455	356	214	965	1,179	871	413	356	1,460	0	28	26	81
72	993	169	129	877	1,006	651	314	440	1,334	126	32	35	101
73	1,739	437	239	986	1,225	827	689	452	1,571	0	40	32	70
74	2,019	844	299	1,015	1,314	966	468	390	1,649	0	23	26	65
75	1,811	641	299	1,015	1,314	951	483	411	1,721	0	27	28	73
76	497	180	163	744	907	478	7	506	1,222	499	1	47	182
77	206	105	93	694	787	206	0	642	580	642	0	74	382
78	2,401	238	238	965	1,203	983	1,373	245	1,708	0	57	18	50
79	1,735	716	299	1,015	1,314	840	443	522	1,629	79	26	36	76
80	2,772	1,530	299	1,015	1,314	1,050	470	326	1,773	0	17	20	47
81	903	287	190	874	1,064	688	124	459	1,438	335	14	35	118
82	3,473	2,067	253	986	1,239	1,068	636	301	1,773	0	18	14	36
83	4,466	3,365	299	1,015	1,314	1,245	340	340	1,773	0	8	5	29
84	2,295	1,526	299	1,015	1,314	922	170	494	1,449	324	7	30	57
85	1,059	204	188	874	1,062	748	281	376	1,354	95	27	30	100
86	2,639	1,215	239	986	1,225	921	707	352	1,709	0	27	25	46
87	506	163	163	744	907	456	44	517	1,236	473	9	50	179
88	502	111	102	694	796	386	108	470	874	362	22	52	159
89	1,010	128	115	694	809	555	416	285	1,005	0	41	31	80
90	591	125	103	694	797	514	71	351	725	280	12	36	135
91	812	109	102	694	796	553	237	272	690	35	29	31	98
92	764	115	102	694	796	553	180	272	598	92	24	31	104
93	2,138	238	238	965	1,203	924	1,184	318	1,464	0	55	23	56
94	650	184	176	744	920	547	83	428	1,119	345	13	41	142
Minimum	206	105	93	694	787	206	0	245	475	0	0	5	29
Average	1,542	549	209	912	1,121	759	432	421	1,326	146	28	32	73
Maximum	4,466	3,365	299	1,018	1,314	1,245	1,373	642	1,773	642	57	74	382

Table 19. Historic Merced River Water Allocation

Water Year	Inflow (TAF)	Downstream Flow (TAF)	Estimated Requirement (TAF)	Diversions (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
67	1,716	646	47	572	619	458	724	273	718	0	42	26	36
68	426	146	40	604	644	318	63	426	355	363	15	51	151
69	2,188	1,158	42	612	654	470	759	365	750	0	35	28	30
70	883	388	47	640	687	410	303	492	561	188	34	40	78
71	733	114	47	549	596	343	296	266	592	0	40	43	81
72	550	191	40	633	673	372	124	424	292	300	23	45	122
73	1,108	84	42	619	661	398	677	295	673	0	61	40	60
74	1,133	385	47	672	719	440	384	334	723	0	34	39	63
75	1,108	459	47	645	692	427	394	411	705	18	36	38	62
76	298	152	40	564	604	267	6	468	243	462	2	56	203
77	150	55	35	208	243	139	2	152	94	150	1	43	162
78	1,756	487	42	553	595	484	882	209	767	0	50	19	34
79	1,075	489	47	639	686	405	388	488	667	100	36	41	64
80	1,646	919	47	661	708	531	429	410	686	0	26	25	43
81	501	168	40	624	664	303	149	488	346	340	30	54	133
82	1,947	897	42	591	633	479	677	258	765	0	35	24	33
83	2,787	2,113	47	623	670	574	526	518	773	0	19	14	24
84	1,181	674	47	659	706	450	354	558	570	204	30	36	60
85	567	232	40	614	654	335	139	466	242	328	24	49	115
86	1,558	519	42	558	600	373	734	281	695	0	47	38	38
87	298	107	40	540	580	227	51	432	314	381	17	61	195
88	415	95	35	419	454	262	88	254	148	166	21	42	109
89	534	77	35	415	450	268	221	229	140	8	41	41	84
90	406	92	35	286	321	208	125	156	108	32	31	35	79
91	560	67	35	341	376	185	321	235	194	0	57	51	67
Minimum	150	55	35	208	243	139	2	152	94	0	1	14	24
Average	1,021	428	42	554	596	365	353	356	485	122	35	39	58
Maximum	2,787	2,113	47	672	719	574	882	558	773	462	61	61	203

Table 20. No-Action Merced River Water Allocation

Water Year	Total Runoff (TAF)	Downstream Flow (TAF)	Fish Flow Required (TAF)	Total Diversions (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
									227				
22	1,450	198	47	600	647	474	812	210	829	0	56	27	45
23	967	407	47	600	647	462	276	363	742	87	29	29	67
24	261	143	40	365	405	198	8	310	440	302	3	51	155
25	936	92	42	595	637	436	447	242	645	0	48	32	68
26	643	133	40	453	493	411	170	155	660	0	26	17	77
27	1,014	178	42	597	639	610	288	97	851	0	28	5	63
28	803	356	47	600	647	608	72	265	658	193	9	6	81
29	522	86	40	365	405	381	66	52	672	0	13	6	78
30	519	89	35	360	395	373	69	57	684	0	13	6	76
31	251	91	35	360	395	190	2	256	430	254	1	52	157
32	1,136	141	42	595	637	440	580	226	784	0	51	31	56
33	542	226	40	453	493	314	127	305	606	178	23	36	91
34	362	85	35	362	397	192	151	293	464	142	42	52	110
35	1,194	236	42	595	637	418	577	263	778	0	48	34	53
36	1,172	552	47	600	647	429	312	339	751	27	27	34	55
37	1,236	559	47	600	647	414	348	326	773	0	28	36	52
38	2,103	1,368	47	600	647	522	348	270	851	0	17	19	31
39	479	291	40	453	493	256	129	454	526	325	27	48	103
40	1,112	278	42	597	639	397	460	270	716	0	41	38	57
41	1,483	692	47	600	647	502	348	213	851	0	23	22	44
42	1,311	655	47	600	647	513	348	348	851	0	27	21	49
43	1,311	729	47	600	647	440	329	402	778	73	25	32	49
44	697	216	47	600	647	421	185	346	617	161	27	35	93
45	1,116	284	47	600	647	443	421	237	801	0	38	32	58
46	962	417	47	600	647	412	293	395	699	102	30	36	67
47	592	210	40	453	493	283	151	265	585	114	26	43	83
48	705	77	42	597	639	419	245	252	578	7	35	34	91
49	648	84	47	600	647	391	220	294	504	74	34	40	100
50	729	103	47	600	647	394	275	286	493	11	38	39	89
51	1,245	542	47	600	647	393	358	304	547	0	29	39	52
52	1,580	620	47	600	647	516	492	188	851	0	31	20	41
53	638	329	47	600	647	429	75	406	520	331	12	34	101
54	675	66	47	600	647	356	298	329	489	31	44	45	96
55	557	75	40	453	493	311	211	217	483	6	38	37	89
56	1,689	669	42	597	639	500	564	196	851	0	33	22	38
57	658	284	47	600	647	412	161	428	584	267	24	36	98
58	1,430	507	47	600	647	504	457	191	850	0	32	22	45
59	459	284	40	453	493	279	91	427	514	336	20	43	107
60	483	54	35	362	397	238	222	212	524	0	46	40	82
61	314	77	35	360	395	218	51	224	351	173	16	45	126
62	947	99	42	595	637	423	454	240	565	0	48	34	67
63	1,002	198	47	600	647	453	395	238	722	0	39	30	65
64	479	209	40	453	493	311	39	261	500	222	8	37	103
65	1,376	373	42	597	639	496	549	198	851	0	40	22	46
66	693	410	47	600	647	333	151	510	492	359	22	49	93
67	1,720	705	47	600	647	535	551	192	851	0	32	17	38
68	421	279	40	453	493	268	66	435	482	369	16	46	117
69	2,216	1,195	42	597	639	510	560	191	851	0	25	20	29
70	890	518	47	600	647	413	158	429	580	271	18	36	73
71	733	95	47	600	647	421	248	251	577	3	34	35	88
72	584	97	40	453	493	316	200	206	571	6	34	36	84
73	1,135	285	42	597	639	418	462	255	778	0	41	35	56
74	1,164	495	47	600	647	434	348	342	784	0	30	33	56
75	1,136	458	47	600	647	452	348	330	802	0	31	30	57
76	291	223	40	365	405	203	13	362	453	349	4	50	139
77	135	60	35	360	395	134	0	334	119	334	0	66	293
78	1,767	397	42	589	631	553	909	177	851	0	51	12	36
79	1,074	526	47	600	647	427	322	422	751	100	30	34	60
80	1,655	899	47	600	647	527	348	248	851	0	21	19	39
81	511	262	40	453	493	299	151	398	604	247	30	39	96
82	1,960	1,061	42	597	639	546	430	183	851	0	22	15	33
83	2,797	2,140	47	600	647	617	348	348	851	0	12	5	23
84	1,159	723	47	600	647	410	237	452	636	215	20	37	56
85	562	87	40	453	493	284	226	245	617	19	40	42	88
86	1,573	752	42	597	639	435	410	235	792	0	26	32	41
87	306	165	40	365	405	203	71	349	514	278	23	50	132
88	378	54	35	360	395	224	123	212	425	89	33	43	104
89	511	61	35	360	395	240	236	198	463	0	46	39	77
90	373	71	35	360	395	226	112	221	354	109	30	43	106
91	527	55	35	360	395	258	234	171	417	0	44	35	75
92	441	60	35	360	395	226	178	209	386	31	40	43	90
93	1,450	358	42	595	637	477	642	192	836	0	44	25	44
94	334	234	40	365	405	218	61	383	514	322	18	46	121
Minimum	135	54	35	360	395	134	0	52	119	0	0	5	23
Average	935	357	43	525	567	386	282	278	642	89	30	32	61
Maximum	2,797	2,140	47	600	647	617	909	510	851	369	56	66	293

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Table 21. Historic Upper San Joaquin River Water Allocation

Water Year	Unimpaired Inflow (TAF)	Estimated Inflow (TAF)	Flow Below Millerton (TAF)	Estimated Requirement (TAF)	Total Diversion (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Millerton Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
										0				
49	1,164	1,186	1,068	0	195	195	195	281	358	76	77	24	0	16
50	1,311	1,289	974	0	314	314	314	356	354	78	0	28	0	24
51	1,859	1,795	1,216	0	511	511	445	421	353	146	0	23	13	28
52	2,840	2,769	2,084	0	641	641	582	504	461	189	0	18	9	23
53	1,227	1,253	351	0	933	933	697	382	413	158	31	30	25	74
54	1,314	1,270	262	0	1,023	1,023	500	558	573	143	15	44	51	81
55	1,161	1,127	107	0	1,024	1,024	684	372	376	139	4	33	33	91
56	2,960	2,838	1,226	0	1,558	1,558	1,319	586	533	193	0	21	15	55
57	1,327	1,348	149	0	1,232	1,232	904	331	365	159	34	25	27	91
58	2,631	2,566	1,180	0	1,389	1,389	1,061	445	448	157	2	17	24	54
59	949	1,106	79	0	1,017	1,017	690	375	365	166	0	34	32	92
60	829	838	96	0	725	725	556	239	223	183	0	29	23	87
61	647	621	100	0	544	544	368	195	218	160	23	31	32	88
62	1,924	1,708	75	0	1,647	1,647	1,273	400	414	146	14	23	23	96
63	1,945	1,926	83	0	1,784	1,784	1,507	359	300	205	0	19	16	93
64	922	1,103	70	0	1,066	1,066	704	370	403	172	33	34	34	97
65	2,272	2,012	63	0	1,955	1,955	1,566	426	432	166	6	21	20	97
66	1,299	1,348	62	0	1,290	1,290	943	378	383	162	5	28	27	96
67	3,232	3,149	1,269	0	1,802	1,802	1,541	562	485	240	0	18	14	57
68	862	1,121	58	0	1,137	1,137	905	190	264	166	74	17	20	101
69	4,040	3,799	2,208	0	1,487	1,487	1,261	663	558	270	0	17	15	39
70	1,446	1,499	87	0	1,513	1,513	1,189	277	377	170	100	18	21	101
71	1,418	1,403	48	0	1,373	1,373	999	390	409	151	18	28	27	98
72	1,039	1,028	68	0	965	965	773	227	232	147	5	22	20	94
73	2,047	2,000	285	0	1,718	1,718	1,381	463	466	144	3	23	20	86
74	2,191	2,195	136	0	2,063	2,063	1,734	385	389	139	4	18	16	94
75	1,796	1,787	54	0	1,712	1,712	1,422	339	318	160	0	19	17	96
76	629	810	81	0	665	665	495	277	213	224	0	34	26	82
77	362	360	91	0	296	296	267	51	78	197	27	14	10	82
78	3,402	3,034	1,348	0	1,504	1,504	1,399	543	361	379	0	18	7	50
79	1,830	1,968	107	0	2,076	2,076	1,613	309	523	164	215	16	22	105
80	2,973	2,943	978	0	1,841	1,841	1,639	490	367	288	0	17	11	63
81	1,068	1,128	69	0	1,181	1,181	873	226	349	164	123	20	26	105
82	3,316	3,154	821	0	2,134	2,134	1,981	484	285	364	0	15	7	68
83	4,642	4,711	3,175	0	1,529	1,529	1,495	446	438	371	0	9	2	32
84	2,049	2,091	615	0	1,684	1,684	1,379	242	451	162	209	12	18	81
85	1,129	1,197	64	0	1,125	1,125	832	337	328	171	0	28	26	94
86	3,031	2,882	974	0	1,920	1,920	1,590	606	618	159	12	21	17	67
87	758	983	67	0	907	907	758	200	190	168	0	20	16	92
88	862	833	80	0	775	775	541	253	275	146	22	30	30	93
89	939	905	84	0	827	827	622	242	248	140	6	27	25	91
90	743	743	99	0	600	600	480	210	167	183	0	28	20	81
91	1,034	903	104	0	807	807	609	248	256	175	9	27	25	89
92	809	867	123	0	754	754	536	276	286	165	10	32	29	87
Minimum	362	360	48	0	195	195	195	51	78	76	0	9	0	16
Average	1,732	1,718	508	0	1,210	1,210	969	362	361	182	25	21	20	70
Maximum	4,642	4,711	3,175	0	2,134	2,134	1,981	663	618	379	215	44	51	105

Table 22. No-Action Upper San Joaquin River Water Allocation

Water Year	Total Runoff (TAF)	Downstream Flow (TAF)	Fish Flow Required (TAF)	Total Diversions (TAF)	Total Use (TAF)	Direct Use (TAF)	Storage Increase (TAF)	Storage Release (TAF)	Carryover Storage (TAF)	Carryover Used (TAF)	Percent Inflow to Storage (%)	Percent Use from Storage (%)	Percent Runoff Used (%)
									175				
22	2,315	353	0	1,919	1,919	1,569	381	366	190	0	16	18	83
23	1,661	0	0	1,685	1,685	1,361	292	339	143	47	18	19	101
24	652	0	0	640	640	473	173	179	137	6	27	26	98
25	1,234	0	0	1,198	1,198	998	229	213	153	0	19	17	97
26	1,159	0	0	1,113	1,113	779	369	346	176	0	32	30	96
27	1,947	28	0	1,898	1,898	1,556	350	356	170	6	18	18	97
28	1,178	0	0	1,169	1,169	898	270	283	157	13	23	23	99
29	857	2	0	833	833	635	215	213	159	0	25	24	97
30	855	2	0	822	822	617	230	218	171	0	27	25	96
31	644	1	0	659	659	499	137	173	135	36	21	24	102
32	1,822	3	0	1,772	1,772	1,475	334	310	159	0	18	17	97
33	1,069	3	0	1,069	1,069	838	223	247	135	24	21	22	100
34	854	4	0	785	785	614	232	188	179	0	27	22	92
35	1,714	0	0	1,705	1,705	1,259	442	458	163	16	26	26	99
36	1,844	28	0	1,793	1,793	1,428	378	380	161	2	20	20	97
37	2,196	336	0	1,854	1,854	1,488	360	381	140	21	16	20	84
38	3,612	1,779	0	1,671	1,671	1,435	681	544	277	0	19	14	46
39	1,185	4	0	1,232	1,232	890	286	361	202	75	24	28	104
40	1,669	0	0	1,702	1,702	1,393	267	325	144	58	16	18	102
41	2,599	477	0	2,003	2,003	1,728	400	310	234	0	15	14	77
42	2,236	56	0	2,229	2,229	1,844	324	400	158	76	14	17	100
43	2,077	252	0	1,802	1,802	1,440	378	381	155	3	18	20	87
44	1,277	0	0	1,248	1,248	1,107	163	153	165	0	13	11	98
45	2,094	68	0	1,974	1,974	1,643	371	346	190	0	18	17	94
46	1,728	0	0	1,728	1,728	1,369	351	375	166	24	20	21	100
47	1,145	0	0	1,121	1,121	811	325	323	168	0	28	28	98
48	1,191	3	0	1,161	1,161	907	277	271	174	0	23	22	97
49	1,168	1	0	1,134	1,134	914	245	233	186	0	21	19	97
50	1,303	0	0	1,296	1,296	1,009	284	300	170	16	22	22	99
51	1,828	210	0	1,599	1,599	1,277	333	335	168	2	18	20	87
52	2,746	639	0	2,008	2,008	1,741	526	454	240	0	19	13	73
53	1,296	0	0	1,347	1,347	1,087	203	277	166	74	16	19	104
54	1,301	0	0	1,273	1,273	966	327	321	172	0	25	24	98
55	1,190	0	0	1,157	1,157	895	286	276	182	0	24	23	97
56	2,796	709	0	2,011	2,011	1,733	420	373	229	0	15	14	72
57	1,377	0	0	1,414	1,414	1,092	271	333	167	62	20	23	103
58	2,546	415	0	2,059	2,059	1,762	356	312	211	0	14	14	81
59	1,164	0	0	1,197	1,197	840	314	371	154	57	27	30	103
60	862	4	0	827	827	696	158	145	167	0	18	16	96
61	650	0	0	660	660	457	183	214	136	31	28	31	102
62	1,725	3	0	1,679	1,679	1,327	385	366	155	0	22	21	97
63	1,945	103	0	1,743	1,743	1,461	366	296	225	0	19	16	90
64	1,122	0	0	1,149	1,149	815	298	350	173	52	27	29	102
65	2,028	17	0	1,956	1,956	1,663	342	312	203	0	17	15	96
66	1,372	0	0	1,372	1,372	956	406	431	178	25	30	30	100
67	3,128	1,011	0	1,985	1,985	1,755	583	478	283	0	19	12	63
68	1,134	1	0	1,222	1,222	937	187	300	170	113	16	23	108
69	3,798	2,084	0	1,603	1,603	1,340	658	573	255	0	17	16	42
70	1,516	89	0	1,498	1,498	1,186	232	328	159	96	15	21	99
71	1,417	0	0	1,393	1,393	1,135	275	273	161	0	19	19	98
72	1,045	0	0	1,018	1,018	796	243	237	167	0	23	22	97
73	2,004	73	0	1,914	1,914	1,519	400	409	158	9	20	21	96
74	2,199	55	0	2,125	2,125	1,712	418	426	150	8	19	19	97
75	1,800	0	0	1,758	1,758	1,422	365	346	169	0	20	19	98
76	828	0	0	775	775	567	253	224	198	0	31	27	94
77	376	0	0	433	433	323	48	119	127	71	13	25	115
78	3,041	1,154	0	1,641	1,641	1,473	619	401	345	0	20	10	54
79	1,976	17	0	2,109	2,109	1,715	235	412	168	177	12	19	107
80	2,927	886	0	1,925	1,925	1,667	440	353	255	0	15	13	66
81	1,142	4	0	1,187	1,187	922	206	278	183	72	18	22	104
82	3,140	963	0	1,978	1,978	1,817	488	320	351	0	16	8	63
83	4,703	3,202	0	1,308	1,308	1,272	508	338	521	0	11	3	28
84	2,097	654	0	1,766	1,766	1,468	52	402	171	350	2	17	84
85	1,216	0	0	1,192	1,192	889	319	318	172	0	26	25	98
86	2,924	1,066	0	1,839	1,839	1,494	409	418	163	9	14	19	63
87	1,002	0	0	978	978	744	247	245	165	0	25	24	98
88	853	1	0	816	816	590	253	240	178	0	30	28	96
89	928	2	0	909	909	676	243	247	174	4	26	26	98
90	768	1	0	747	747	557	201	203	172	2	26	25	97
91	926	3	0	897	897	789	126	120	178	0	14	12	97
92	449	0	0	477	477	393	49	94	133	45	11	18	106
93	2,456	283	0	2,065	2,065	1,769	391	311	213	0	16	14	84
94	1,021	0	0	1,038	1,038	791	222	260	175	38	22	24	102
Minimum	376	0	0	433	433	323	48	94	127	0	2	3	28
Average	1,672	234	0	1,415	1,415	1,143	312	312	186	24	19	19	85
Maximum	4,703	3,202	0	2,229	2,229	1,844	681	573	521	350	32	31	115

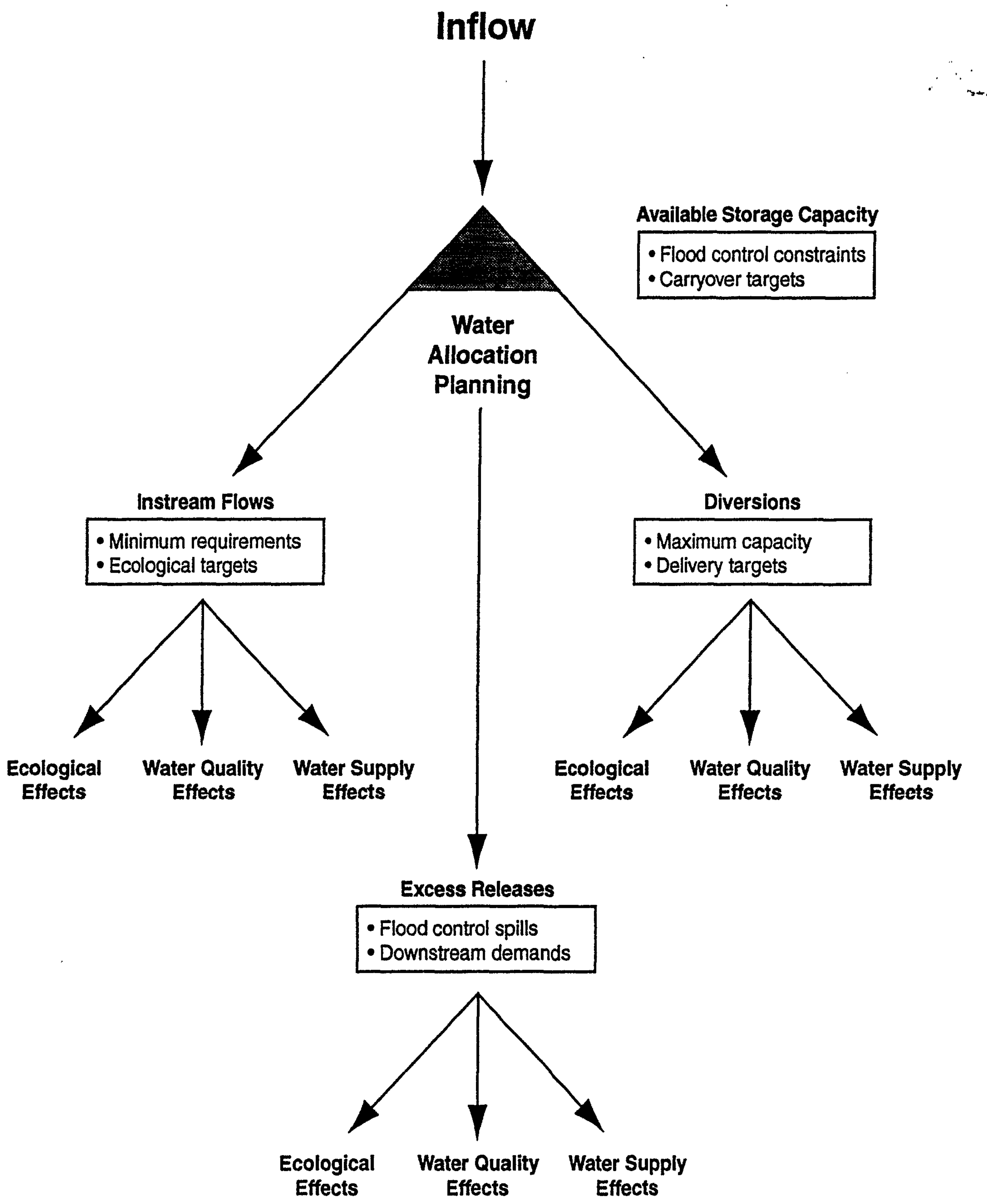

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Figure 1
General Methodology for Evaluating Surface Water Management

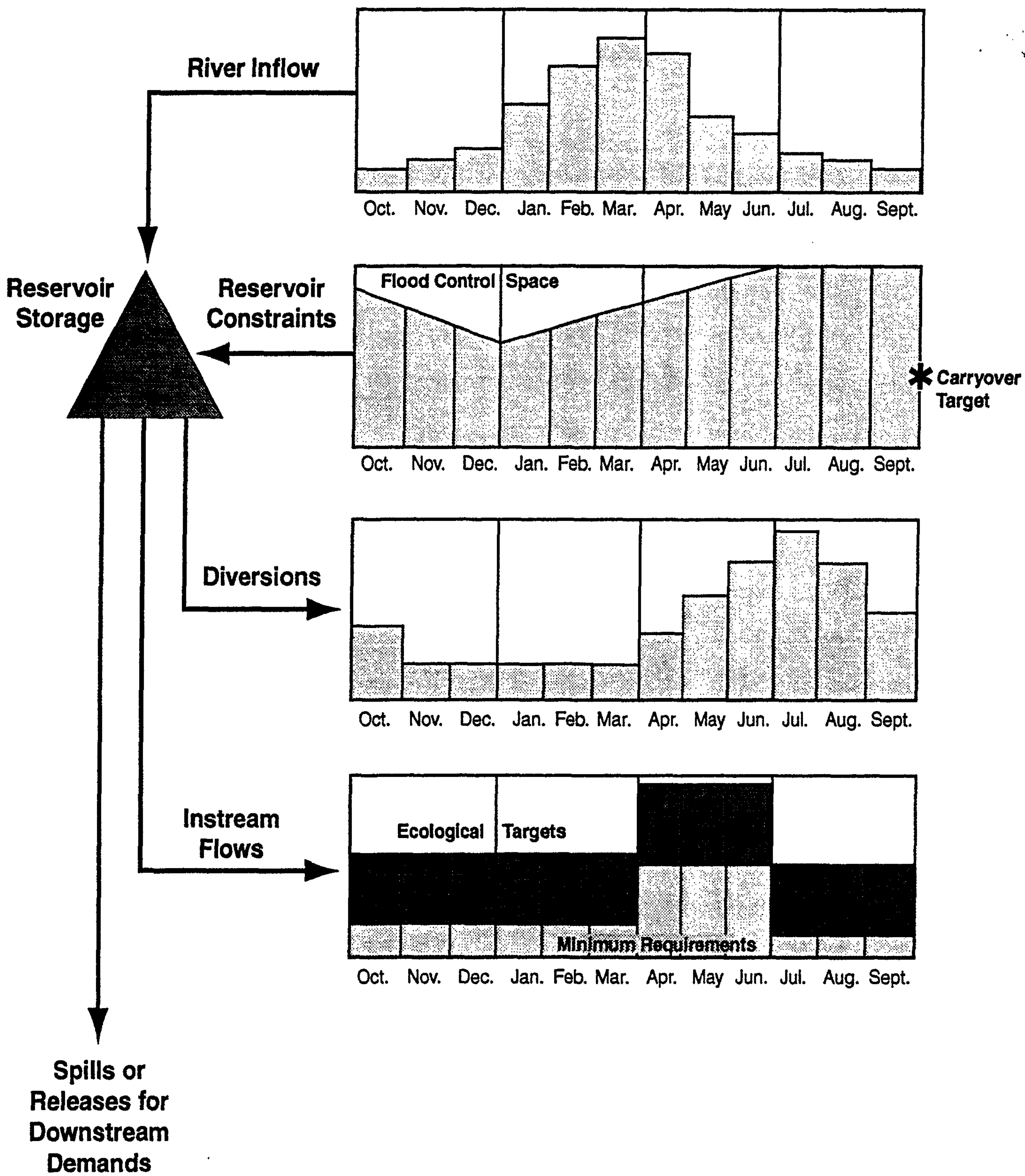

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Figure 2
General Monthly Water Management Framework

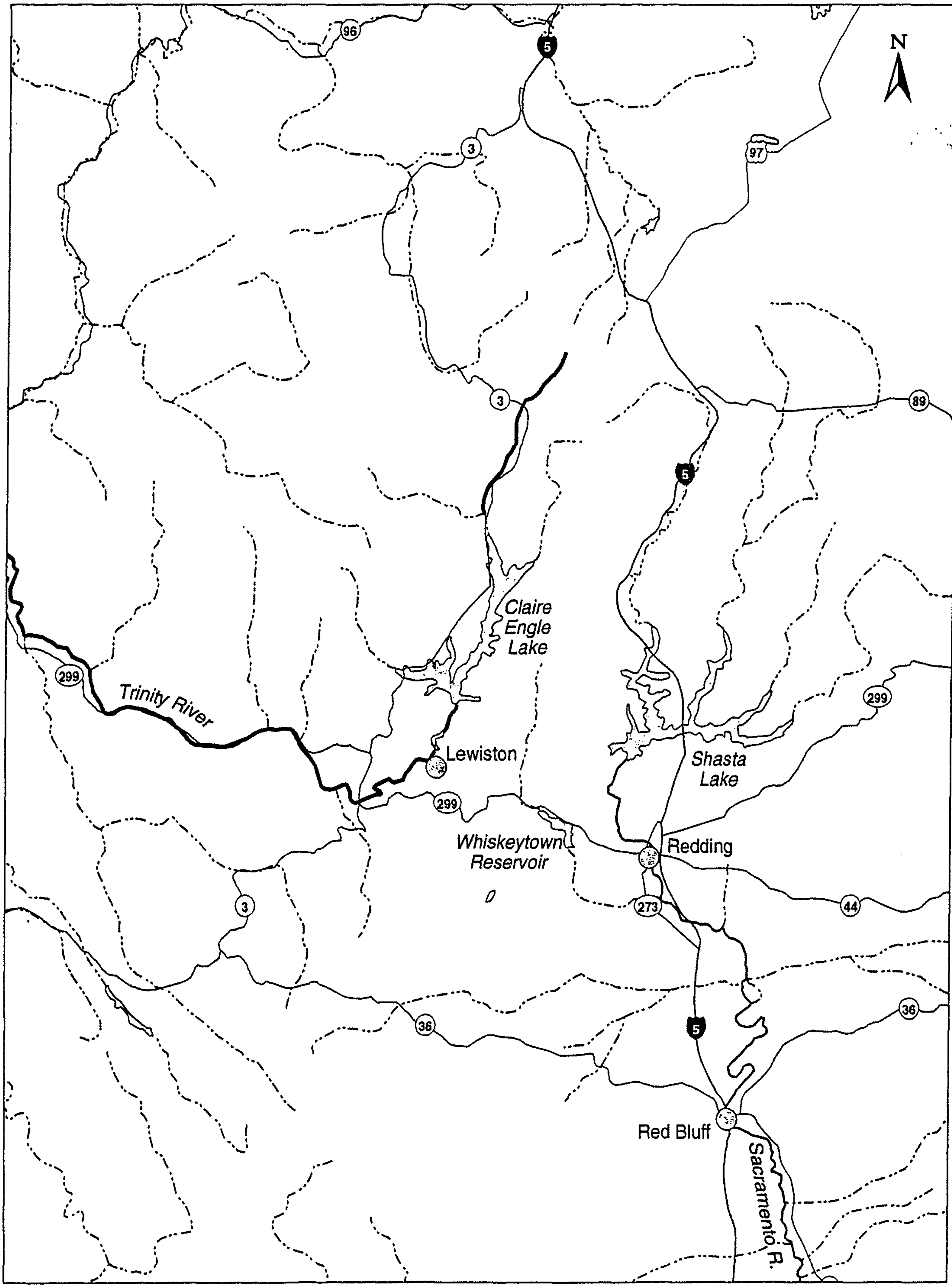

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Figure 3
Trinity River Basin Water Management Facilities

Figure 4

Trinity River Inflow Exceedence

Historic & CALFED No-Action

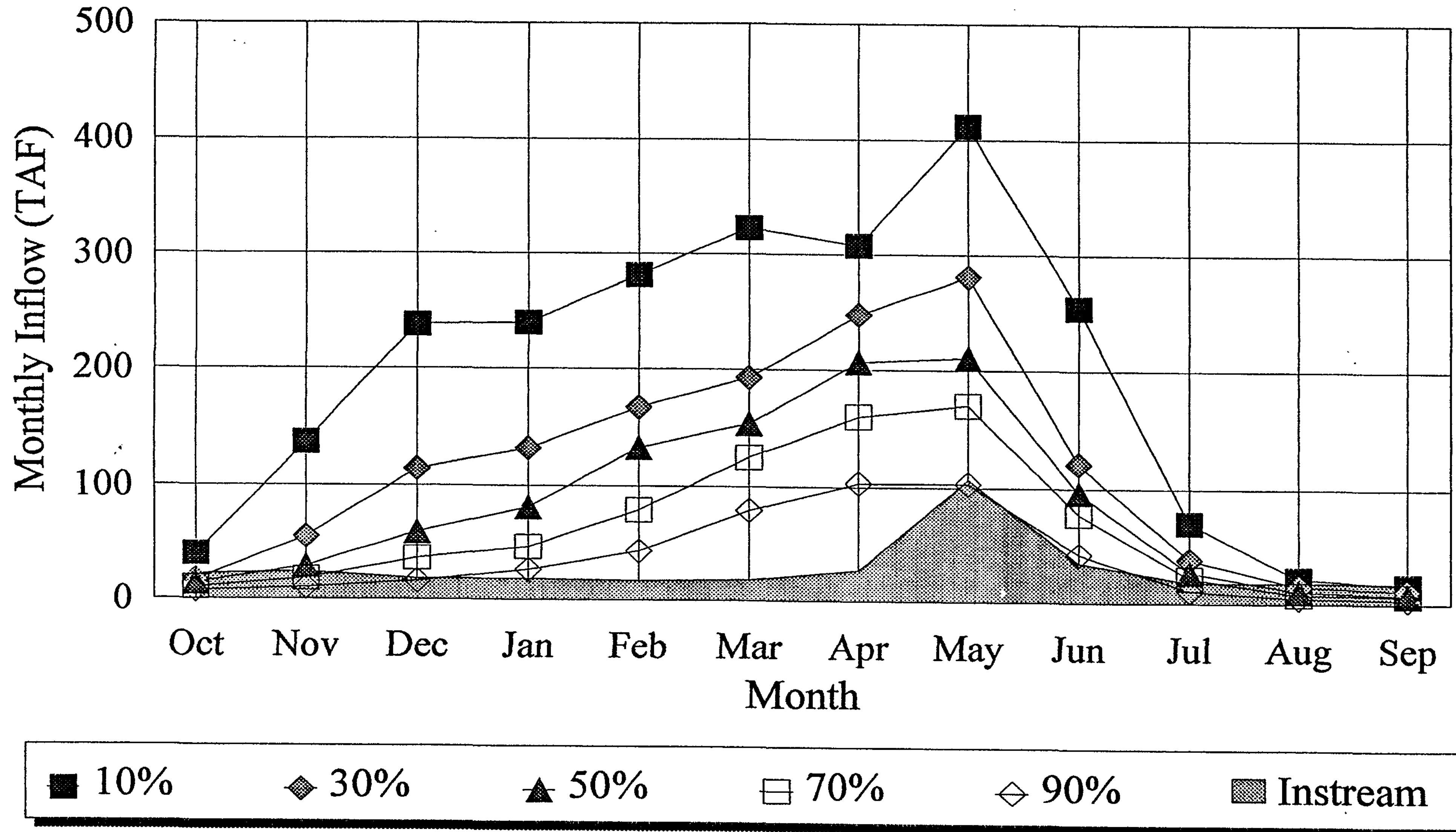
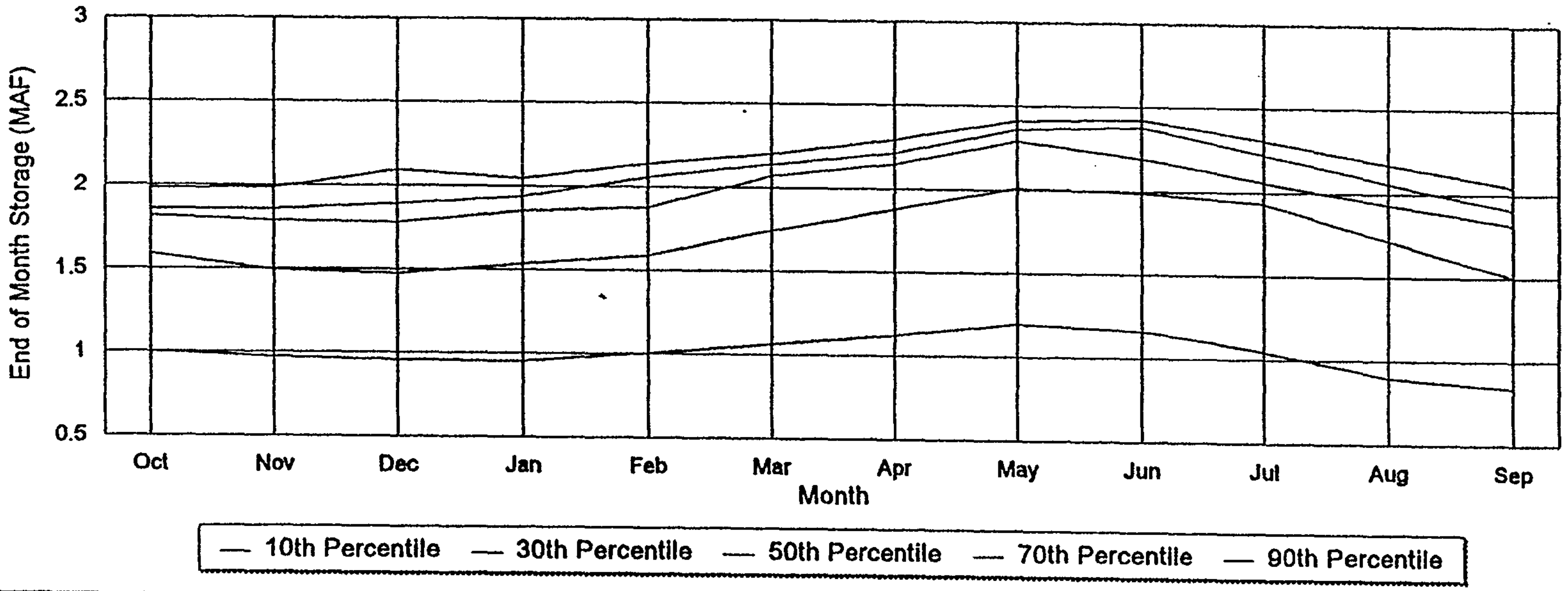


Figure 5

Distribution of End of Month Storage in Clair Engle Lake for Water Years 1972-1992



End of Month Storage in Clair Engle Lake (TAF) for the 1972-1992 Period of Record
Average Storage = 1,773 TAF **Drainage Area = 692 sq. mi.** **Data Source: CDEC**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	224	251	427	547	684	821	1,035	926	766	535	327	242
10%	1,002	970	955	951	1,006	1,062	1,117	1,200	1,159	1,048	897	838
20%	1,279	1,241	1,250	1,276	1,307	1,431	1,502	1,758	1,909	1,729	1,564	1,376
30%	1,588	1,492	1,472	1,534	1,588	1,738	1,873	2,013	1,989	1,929	1,712	1,503
40%	1,633	1,672	1,623	1,685	1,845	1,854	1,956	2,112	2,097	1,976	1,864	1,702
50%	1,816	1,785	1,779	1,846	1,874	2,067	2,144	2,293	2,192	2,058	1,930	1,813
60%	1,834	1,824	1,831	1,873	1,936	2,109	2,179	2,355	2,332	2,190	2,027	1,879
70%	1,851	1,852	1,889	1,932	2,056	2,133	2,214	2,363	2,382	2,224	2,056	1,901
80%	1,904	1,924	1,930	1,984	2,117	2,164	2,239	2,391	2,399	2,284	2,076	1,913
90%	1,981	1,985	2,091	2,045	2,133	2,202	2,295	2,416	2,429	2,310	2,170	2,041
100%	2,063	2,261	2,337	2,480	2,384	2,463	2,364	2,441	2,448	2,420	2,294	2,164

Figure 6

Trinity River Export Exceedence

Historic 1963-1991

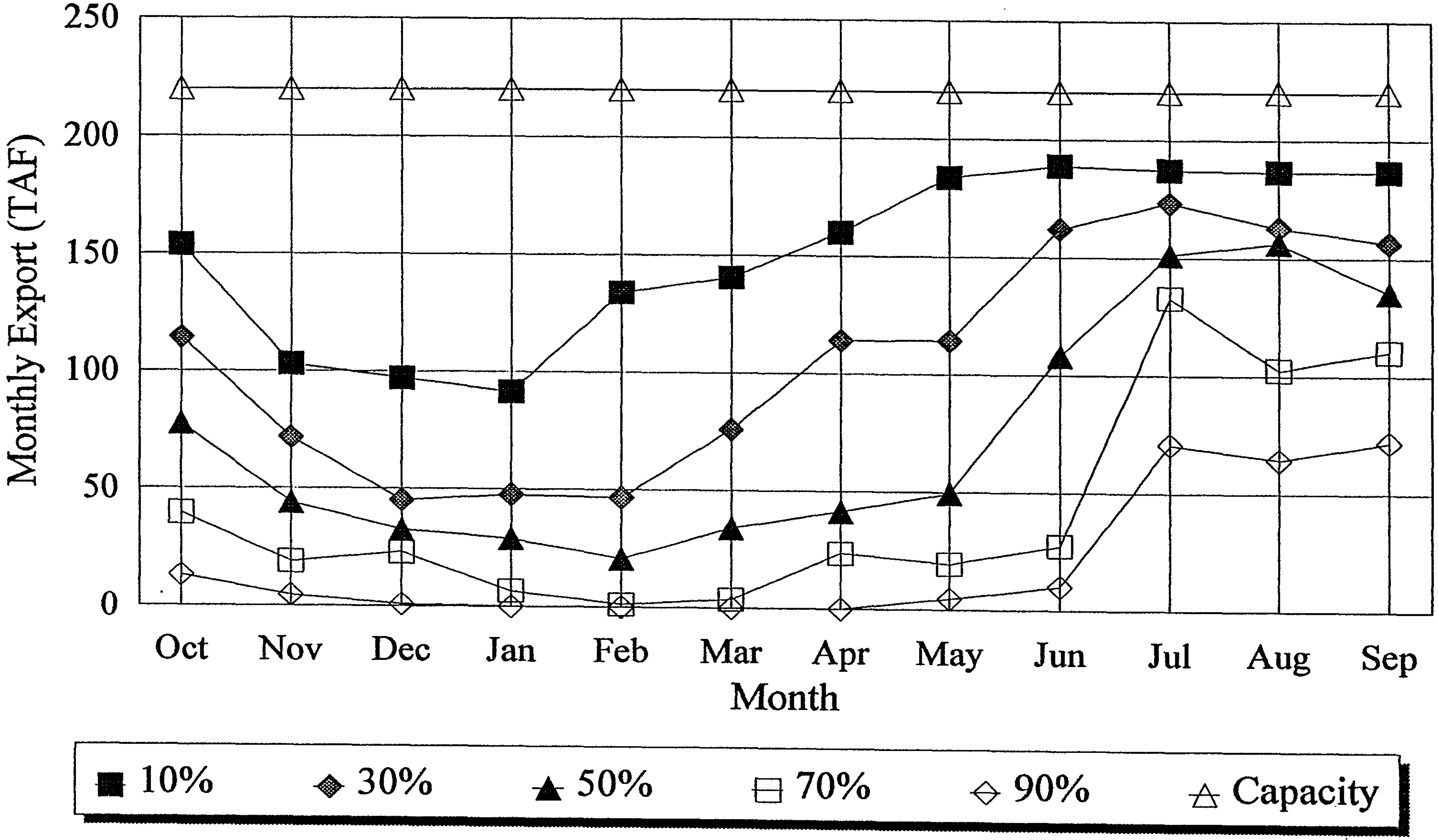


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Figure 7

Trinity River Excedence Flows

Historical 1971-1991

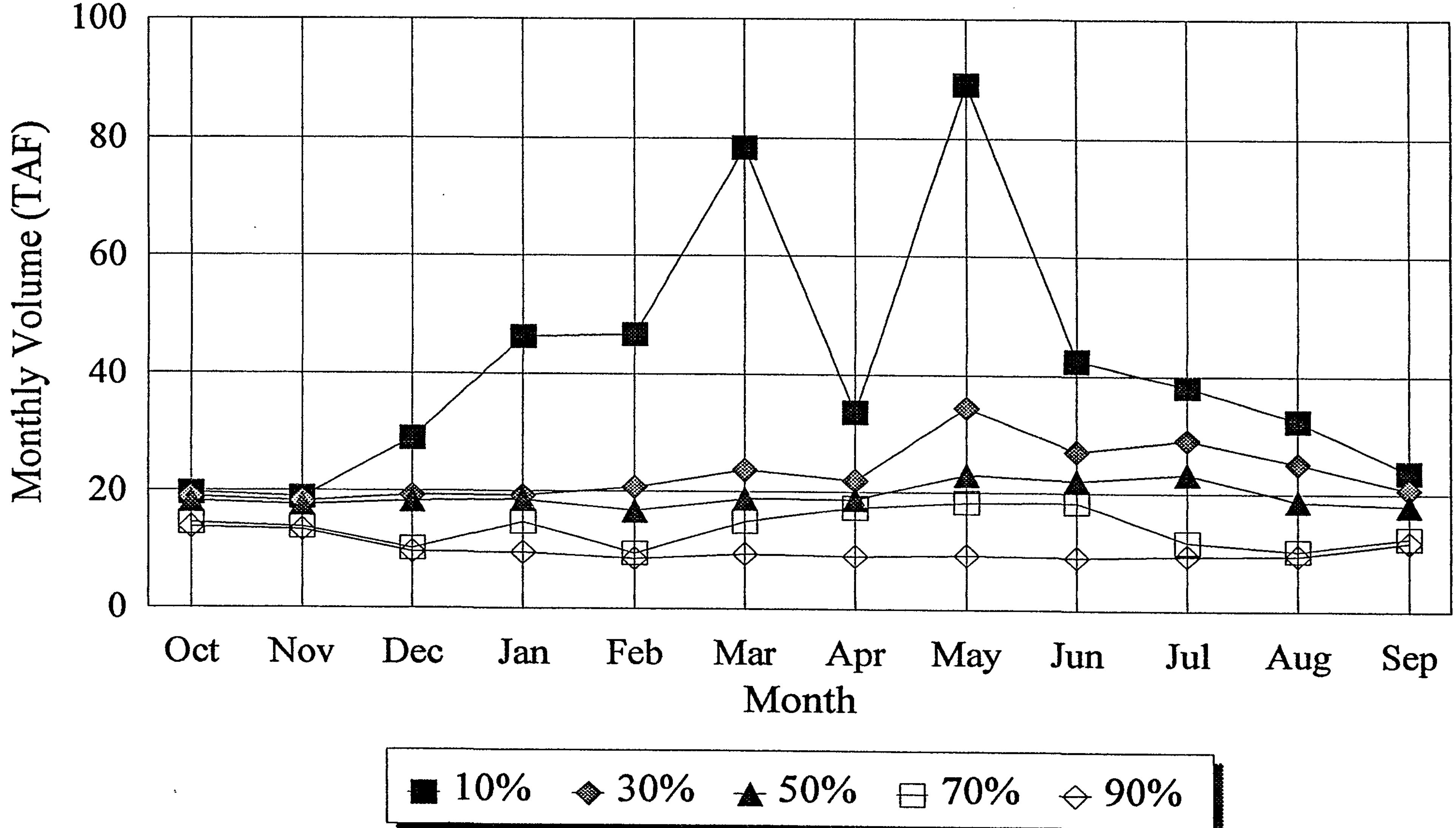
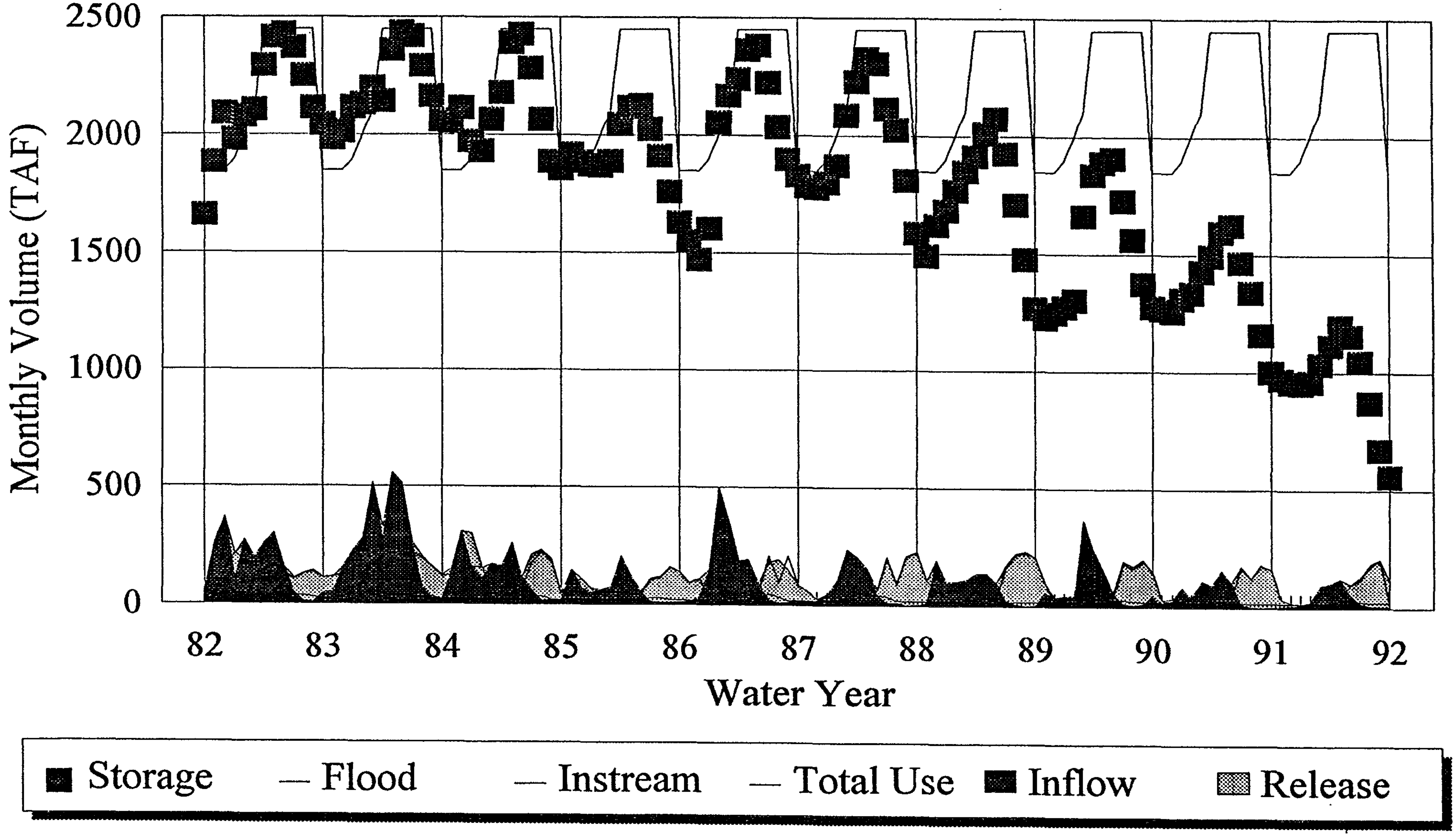


Figure 8

Trinity River Flow Allocation

Historical 1982-1991



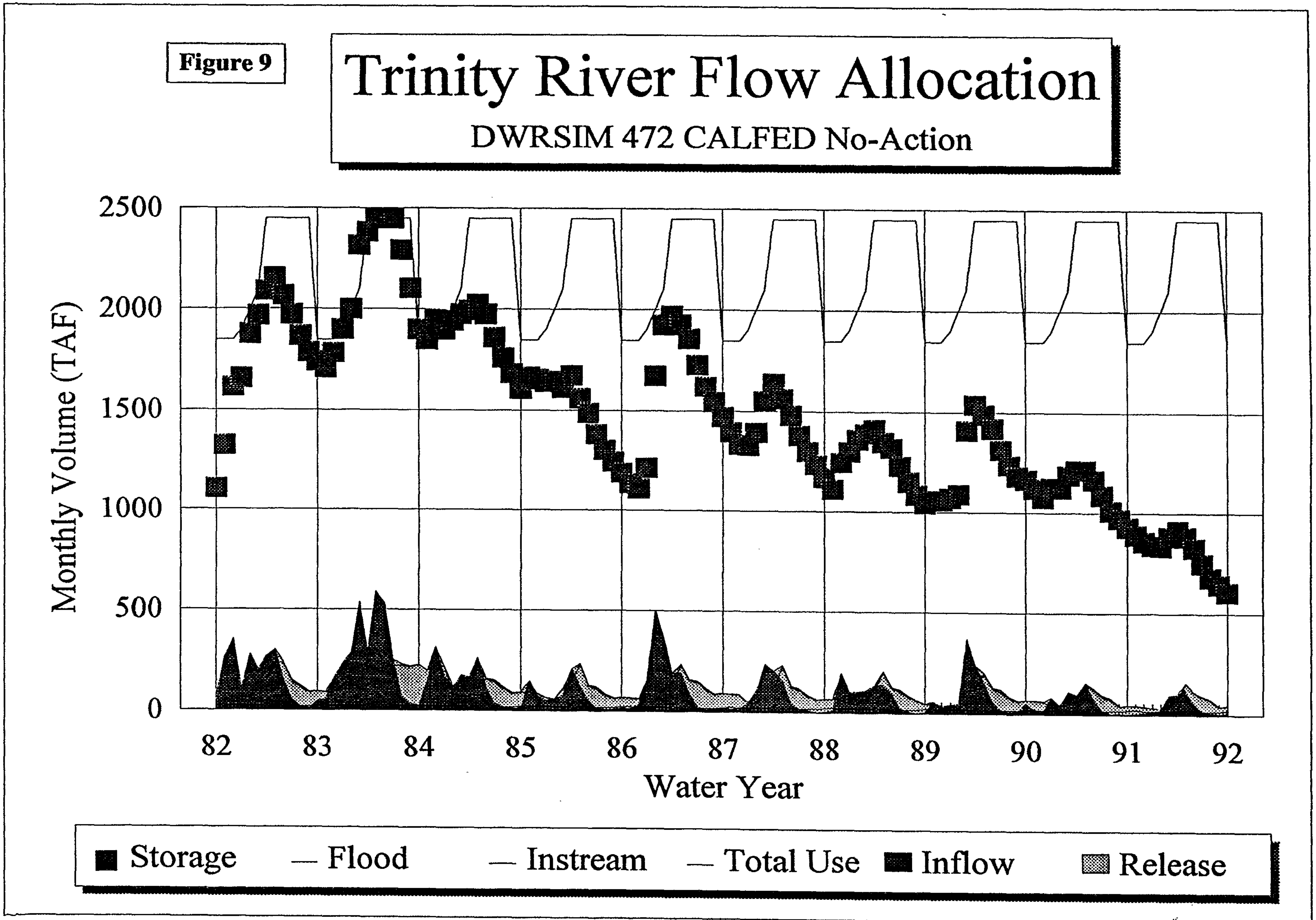


Figure 9
Trinity River Flow Allocation
DWRSIM 472 CALFED No-Action
Monthly Volume (TAF)
2500
2000
1500
1000
500
0
82
83
84
85
86
87
88
89
90
91
92
Water Year
Storage
Flood
Instream
Total Use
Inflow
Release

Figure 10

Trinity River Export Exceedence

DWRSIM 472 CALFED No-Action

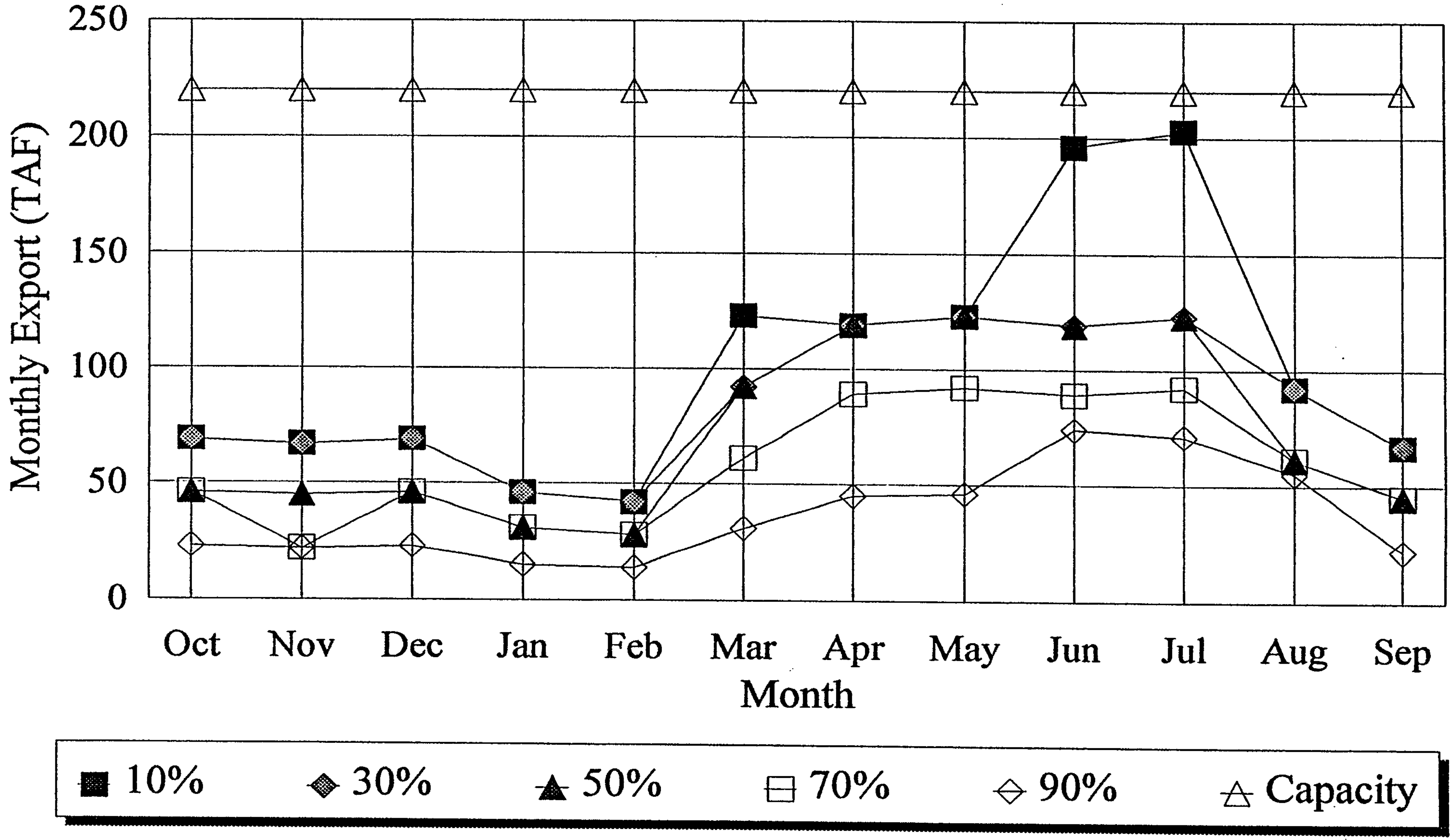


Figure 11

Trinity River Excedence Flows

DWRSIM 472 CALFED No-Action

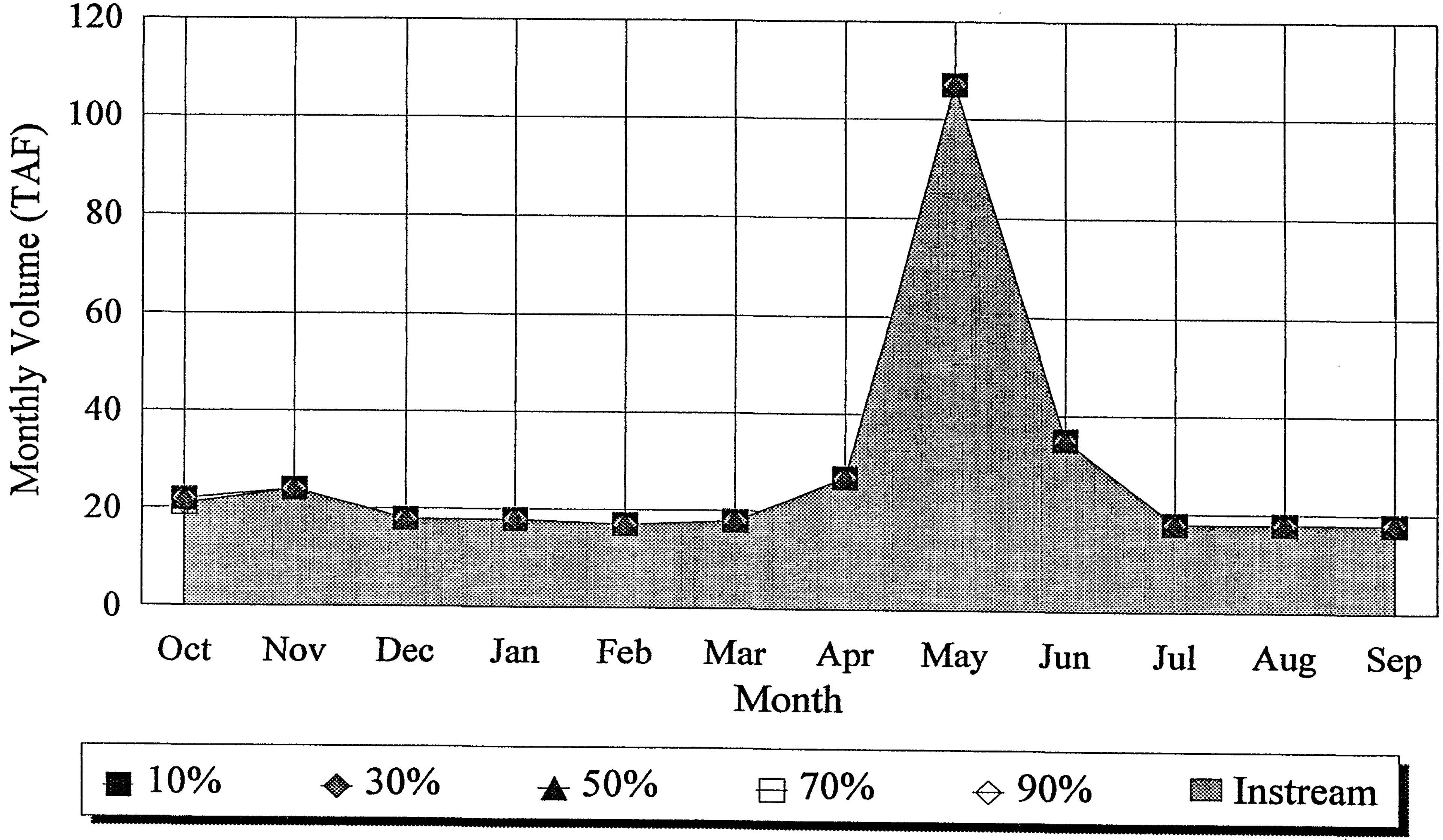
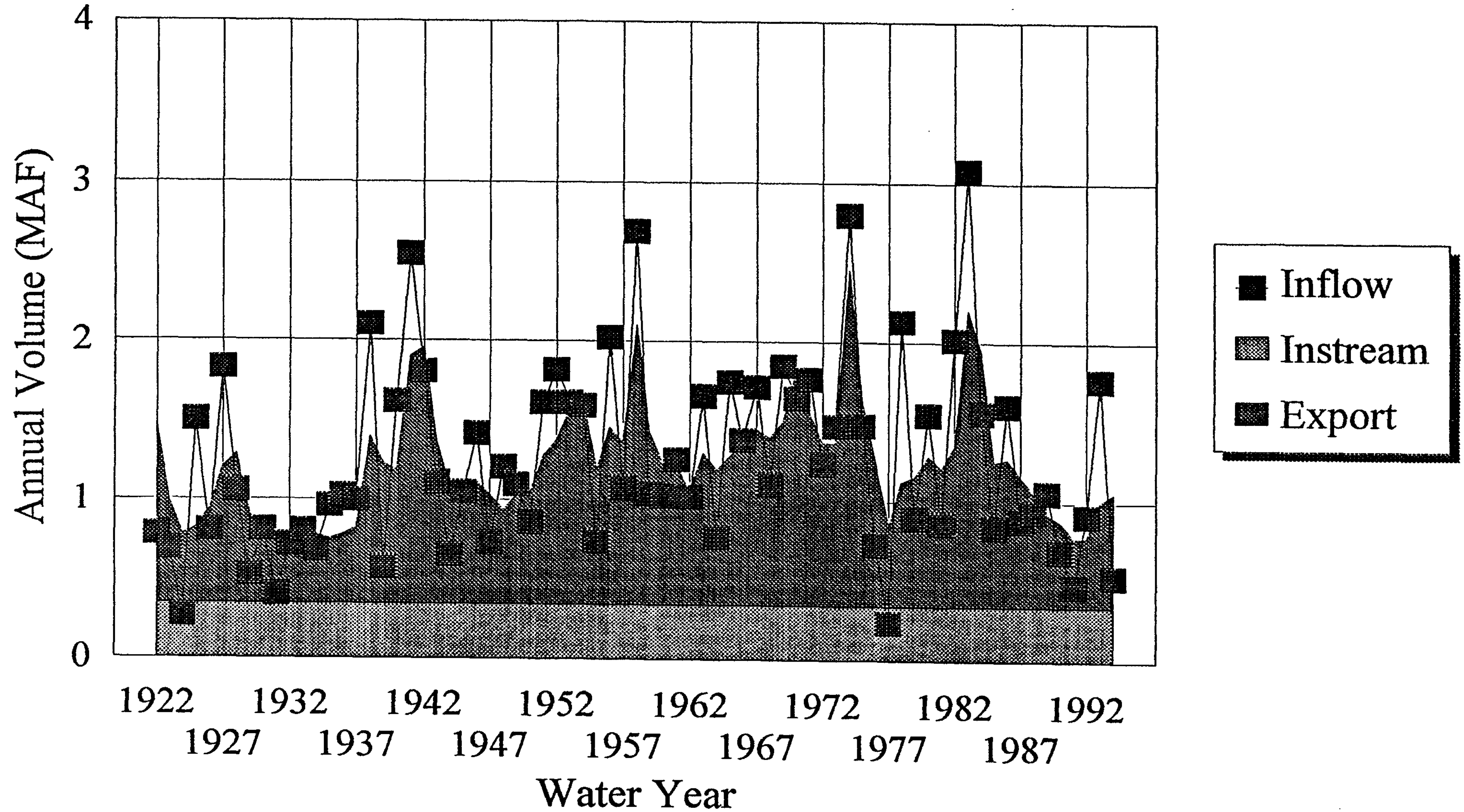


Figure 12

Trinity River Annual Allocation

DWRSIM 472 CALFED No-Action



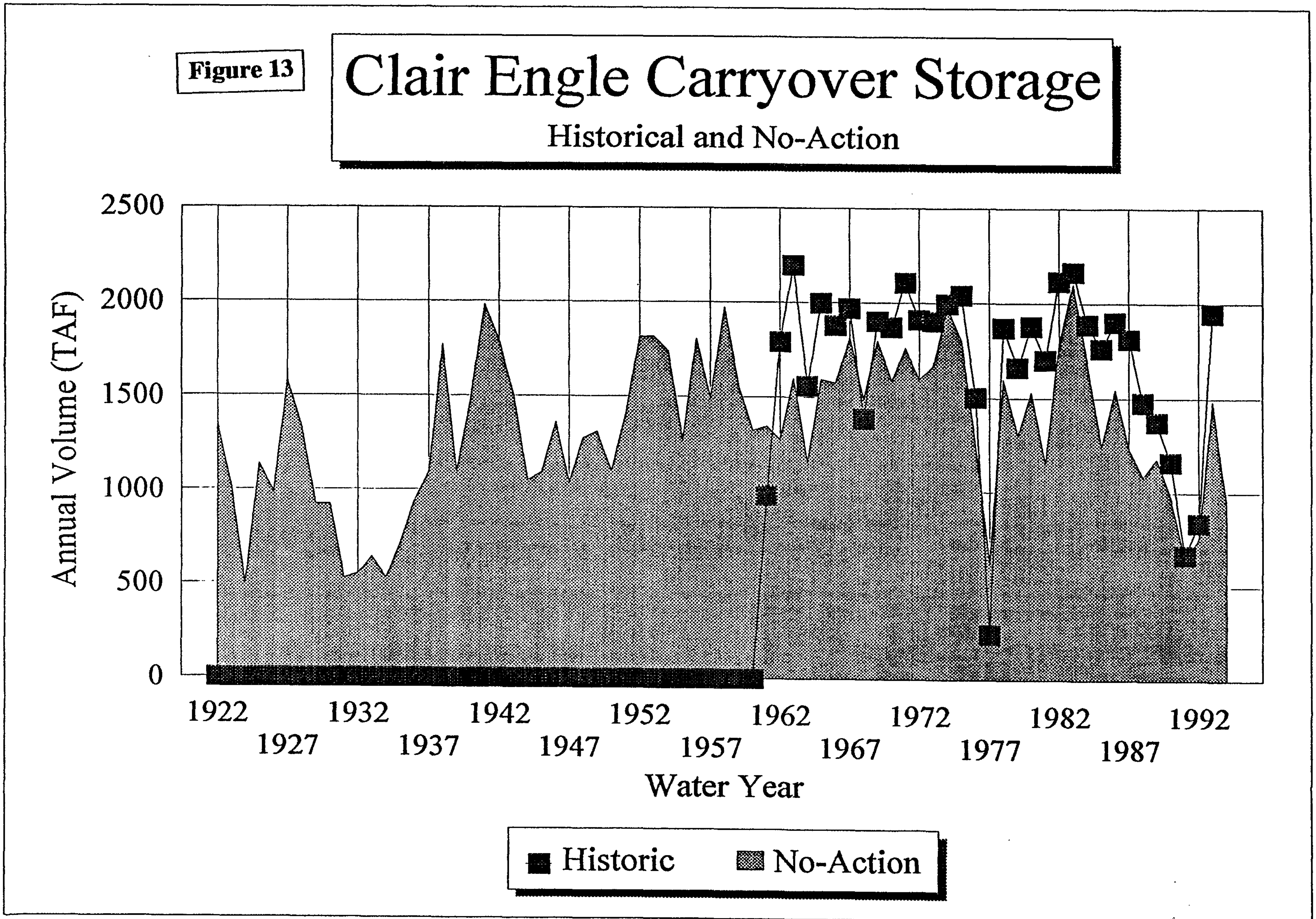
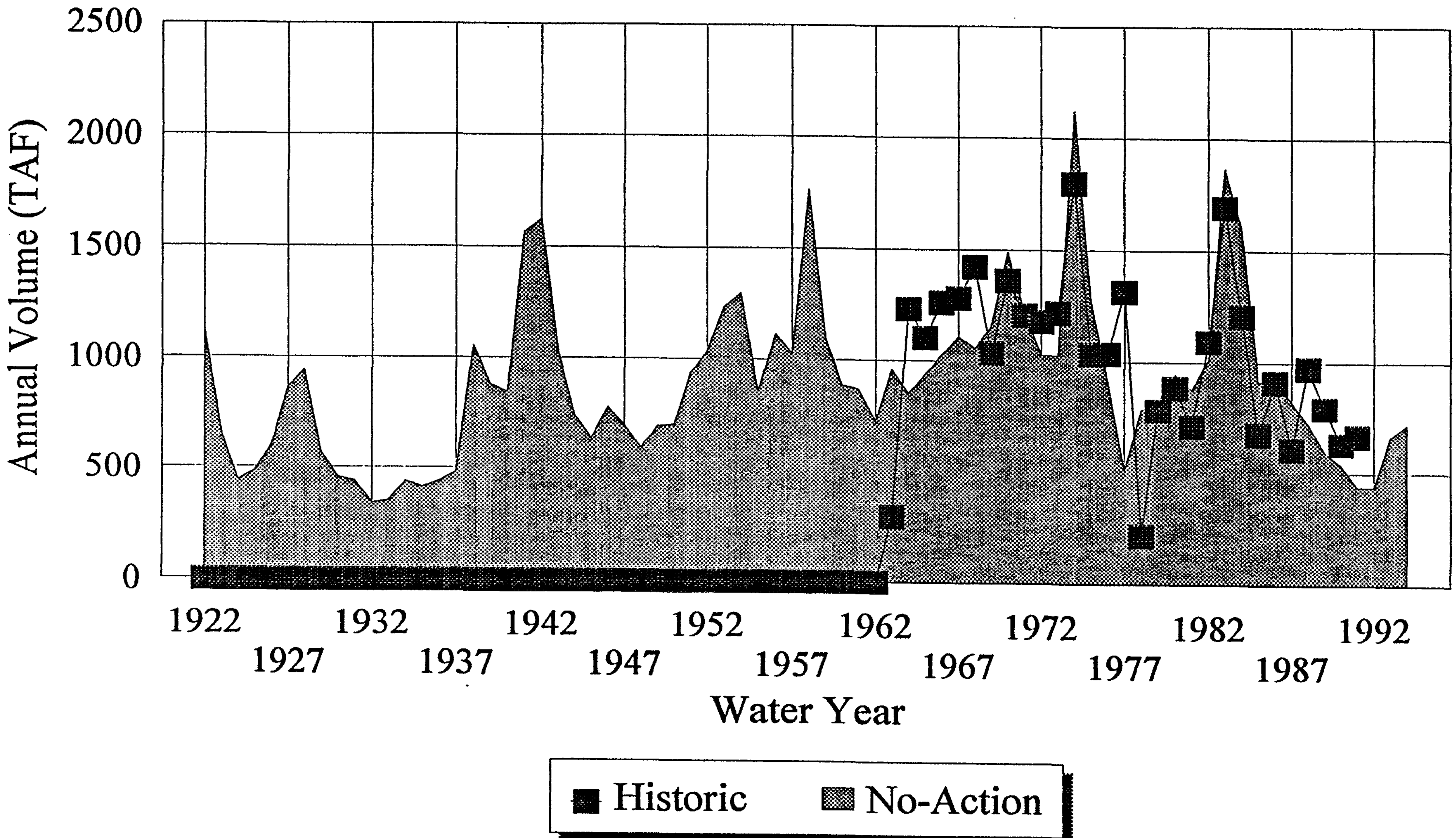


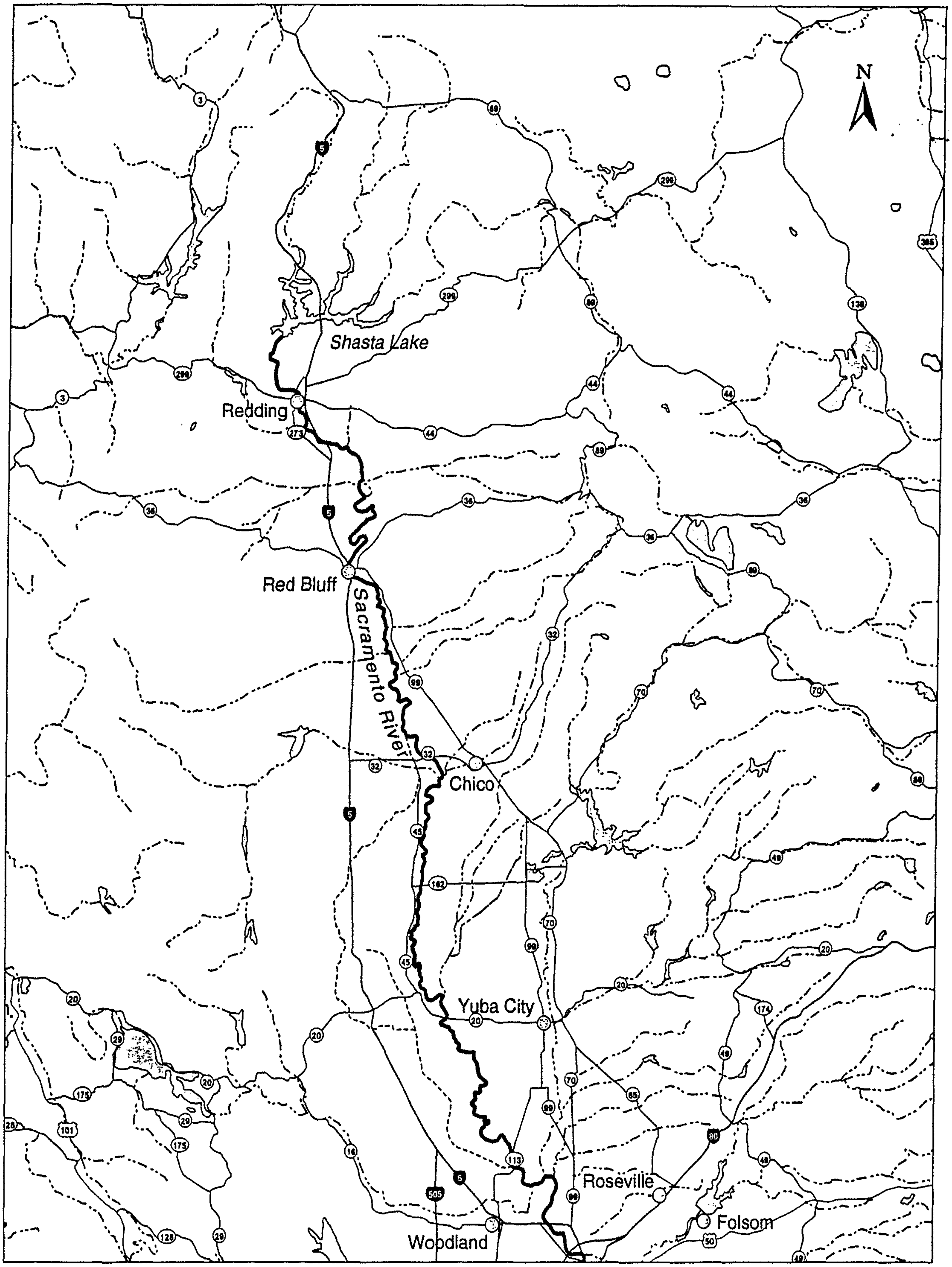
Figure 13
Clair Engle Carryover Storage
Historical and No-Action
Annual Volume (TAF)
2500
2000
1500
1000
500
0
1922
1927
1932
1937
1942
1947
1952
1957
1962
1967
1972
1977
1982
1987
1992
Water Year
Historic
No-Action

Figure 14

Trinity River Export Diversions

Historical and No-Action





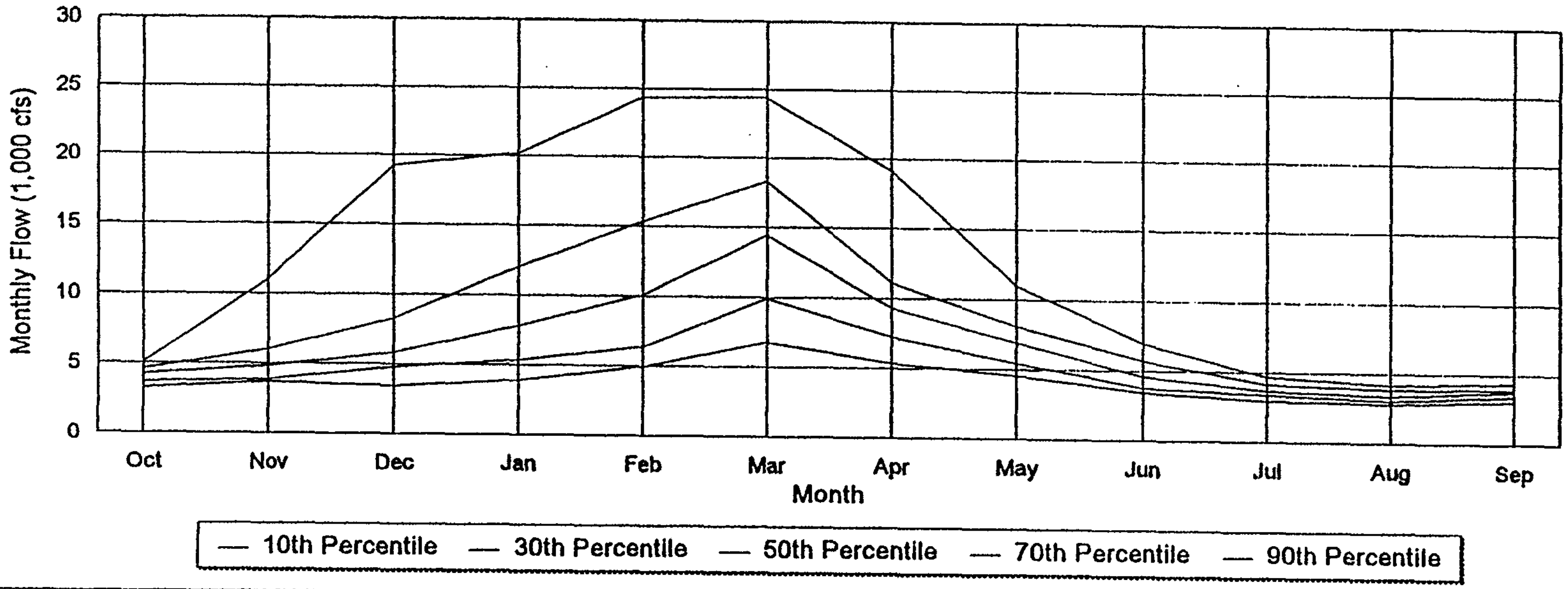
CALFED BAY-DELTA PROGRAM

Figure 15
Sacramento River Basin Water Management Facilities

C-003248

Figure 16

Distribution of Unimpaired Monthly Inflow to Shasta Lake for Water Years 1972-1992



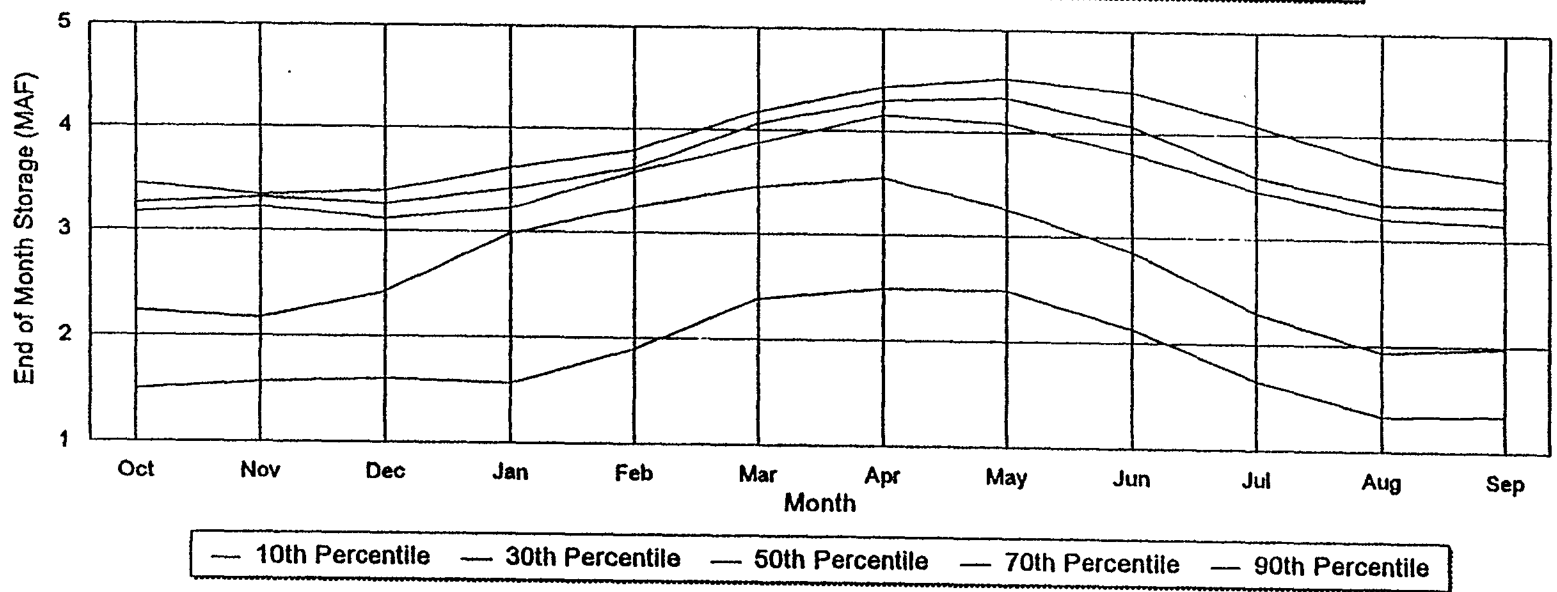
Unimpaired Monthly Inflow to Shasta Lake (cfs) for the 1972-1992 Period of Record
Average Flow = 7,783 cfs **Drainage Area = 6,421 sq. mi.** **Data Source: CDEC**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	3,110	2,981	3,027	3,321	3,822	3,994	3,615	3,935	3,224	2,879	2,606	2,842	2,636
10%	3,225	3,664	3,408	3,877	4,962	6,778	5,370	4,509	3,433	2,967	2,797	3,020	3,593
20%	3,504	3,823	3,741	4,908	6,300	7,675	6,258	4,959	3,707	3,040	2,987	3,232	3,616
30%	3,637	3,854	4,779	5,367	6,377	9,880	7,275	5,459	3,768	3,380	3,045	3,420	3,946
40%	3,768	4,151	5,642	5,727	9,243	12,502	7,644	5,797	3,870	3,492	3,239	3,625	4,022
50%	4,212	4,805	5,825	7,819	10,082	14,399	9,292	6,937	4,548	3,659	3,399	3,738	4,745
60%	4,433	5,033	6,097	9,802	12,521	14,692	9,627	7,772	4,559	3,839	3,585	3,820	6,167
70%	4,560	5,998	8,285	11,970	15,299	18,316	11,079	8,092	5,732	4,126	3,808	3,861	6,405
80%	4,732	7,369	11,037	16,735	19,002	22,786	13,853	9,119	6,000	4,231	4,033	4,074	7,546
90%	5,073	10,993	19,241	20,187	24,372	24,424	19,153	10,928	6,954	4,665	4,169	4,334	9,013
100%	5,305	26,507	23,364	34,139	43,853	44,481	26,482	16,778	10,828	6,071	4,845	4,829	10,796

C-003248

Figure 17

Distribution of End of Month Storage in Shasta Lake for Water Years 1972-1992

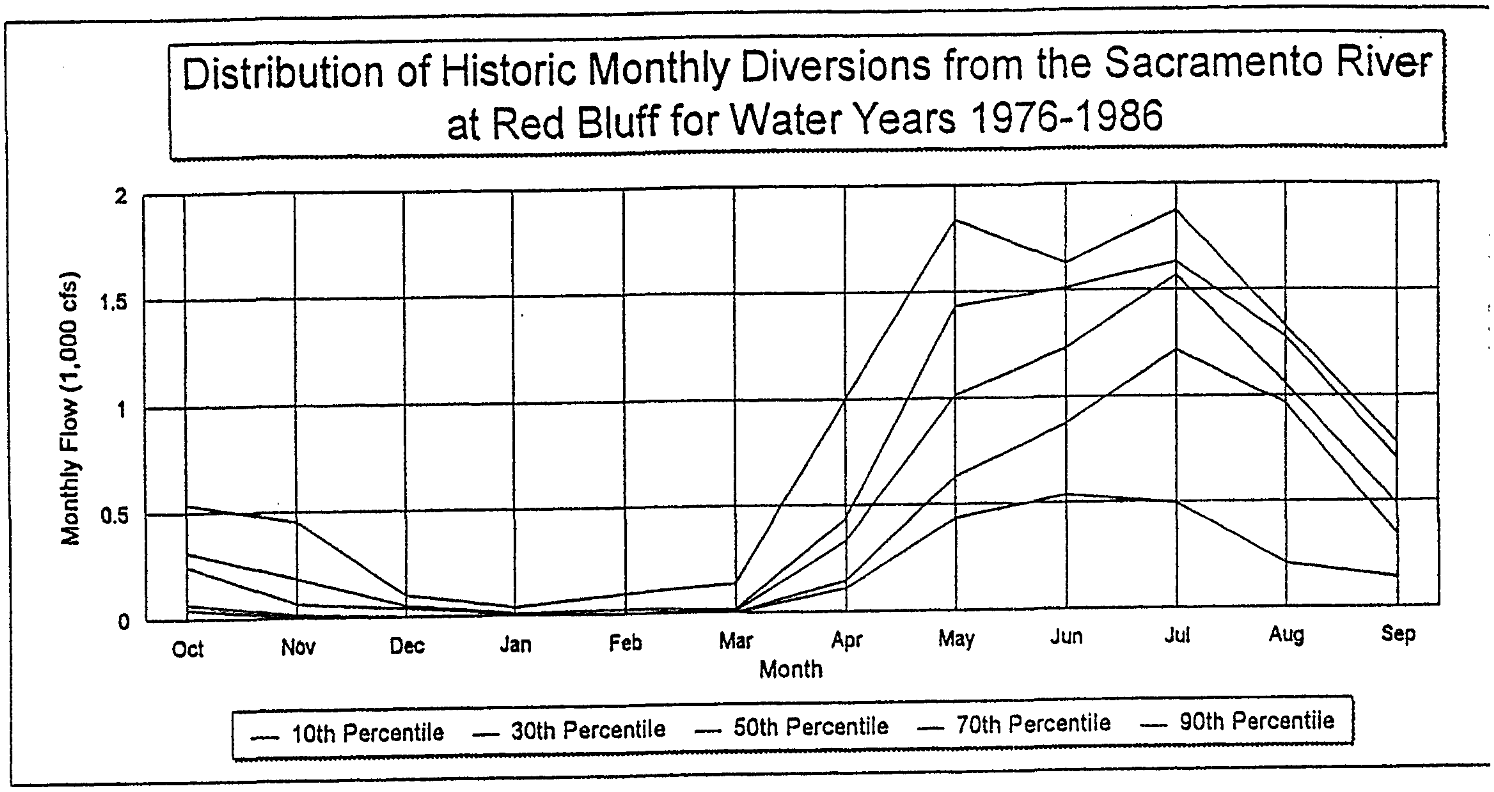


End of Month Storage in Shasta Lake (TAF) for the 1972-1992 Period of Record

Average Storage = 3,056 TAF **Drainage Area = 6,421 sq. mi.** **Data Source: USGS**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	656	648	1,172	1,343	1,486	1,461	1,214	1,127	938	681	578	631
10%	1,493	1,562	1,599	1,564	1,896	2,388	2,484	2,477	2,131	1,654	1,325	1,340
20%	1,679	1,823	1,774	2,317	2,429	3,170	3,014	2,586	2,411	2,061	1,693	1,637
30%	2,231	2,173	2,422	2,980	3,240	3,445	3,546	3,255	2,856	2,292	1,929	1,977
40%	2,560	3,068	2,973	3,045	3,494	3,703	4,036	3,674	3,152	2,620	2,111	2,108
50%	3,162	3,217	3,105	3,218	3,579	3,870	4,154	4,083	3,801	3,451	3,201	3,141
60%	3,231	3,252	3,204	3,339	3,614	3,986	4,286	4,220	3,931	3,556	3,306	3,240
70%	3,257	3,311	3,255	3,404	3,620	4,062	4,298	4,337	4,070	3,587	3,330	3,317
80%	3,332	3,330	3,336	3,454	3,682	4,134	4,363	4,478	4,290	3,907	3,500	3,428
90%	3,438	3,339	3,381	3,606	3,793	4,182	4,432	4,527	4,400	4,086	3,727	3,570
100%	3,554	3,626	3,492	3,740	3,865	4,503	4,519	4,543	4,471	4,191	3,855	3,658

Figure 18


Distribution of Historic Monthly Diversions from the Sacramento River at Red Bluff for Water Years 1976-1986
Monthly Flow (1,000 cfs)
2
1.5
1
0.5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
10th Percentile
30th Percentile
50th Percentile
70th Percentile
90th Percentile

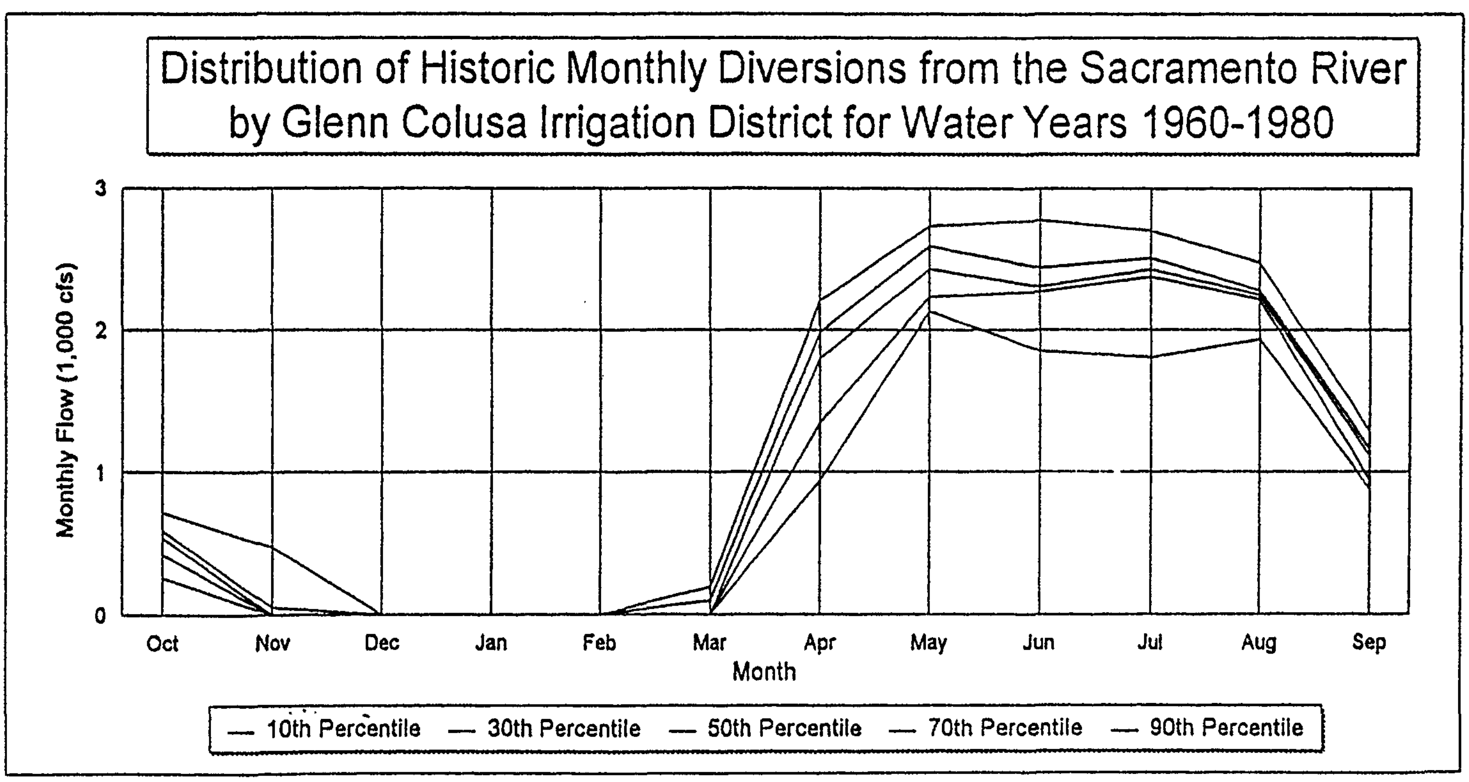
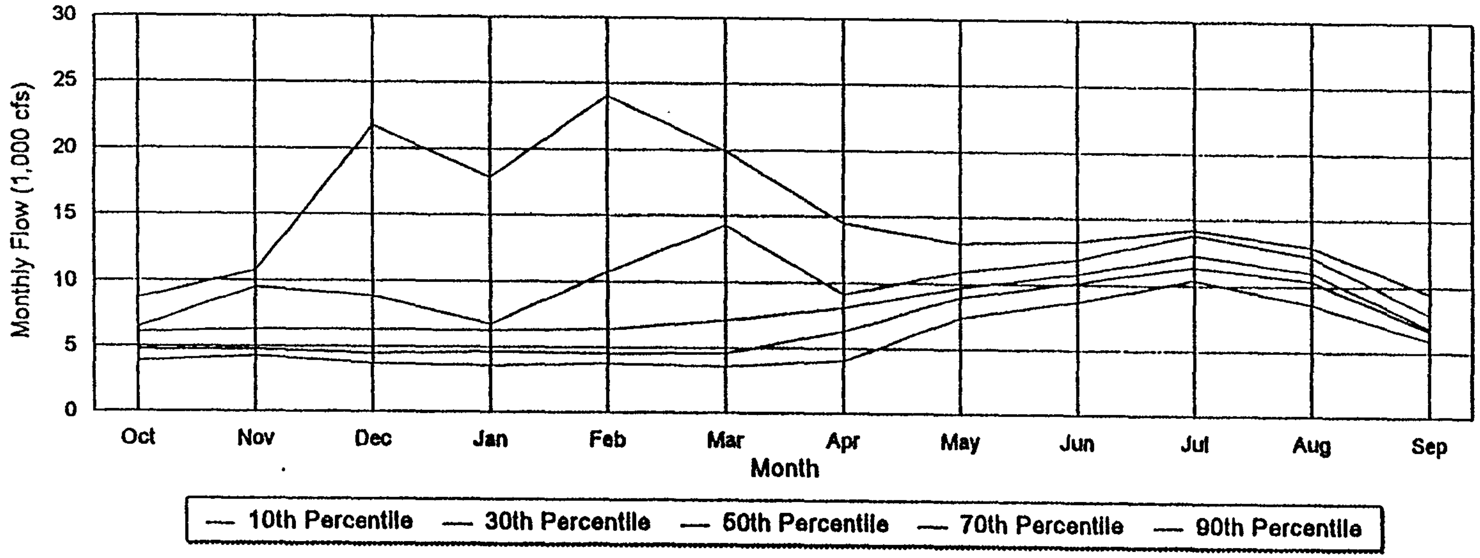

Distribution of Historic Monthly Diversions from the Sacramento River by Glenn Colusa Irrigation District for Water Years 1960-1980
Monthly Flow (1,000 cfs)
3
2
1
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
10th Percentile
30th Percentile
50th Percentile
70th Percentile
90th Percentile

Figure 19

Distribution of Historic Monthly Flow in the Sacramento River at Keswick for Water Years 1972-1992



Historic Monthly Flow in the Sacramento River at Keswick (cfs) for the 1972-1992 Period of Record
Average Flow = 9,707 cfs **Drainage Area = 6,468 sq. mi.** ***Data Source: USGS***

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	3,431	3,662	2,847	3,430	3,268	2,869	3,096	6,953	7,342	7,754	8,070	4,564	3,906
10%	3,822	4,240	3,639	3,506	3,699	3,521	4,026	7,431	8,721	10,445	8,642	5,881	4,639
20%	4,511	4,543	4,014	4,283	3,913	4,439	6,015	7,807	9,552	10,832	9,980	6,547	5,304
30%	4,751	4,751	4,493	4,636	4,544	4,581	6,310	8,997	10,139	11,384	10,378	6,669	5,745
40%	5,011	5,833	6,055	5,815	5,302	5,971	7,218	9,058	10,681	12,013	10,911	6,725	5,892
50%	6,052	6,283	6,296	6,226	6,400	7,120	8,082	9,735	10,807	12,323	11,056	6,919	6,238
60%	6,325	6,763	7,295	6,287	7,033	10,159	8,960	10,384	11,295	13,297	11,971	7,435	7,009
70%	6,507	9,539	8,875	6,765	10,752	14,350	9,180	10,902	11,920	13,884	12,226	7,884	7,783
80%	7,562	10,371	11,588	14,350	17,911	16,813	9,571	12,048	12,607	14,181	12,535	9,038	8,052
90%	8,690	10,756	21,765	17,872	24,040	19,936	14,527	13,061	13,317	14,226	12,984	9,504	9,701
100%	10,288	23,430	27,339	35,974	38,971	47,174	26,843	17,017	14,960	14,739	14,048	10,806	13,199

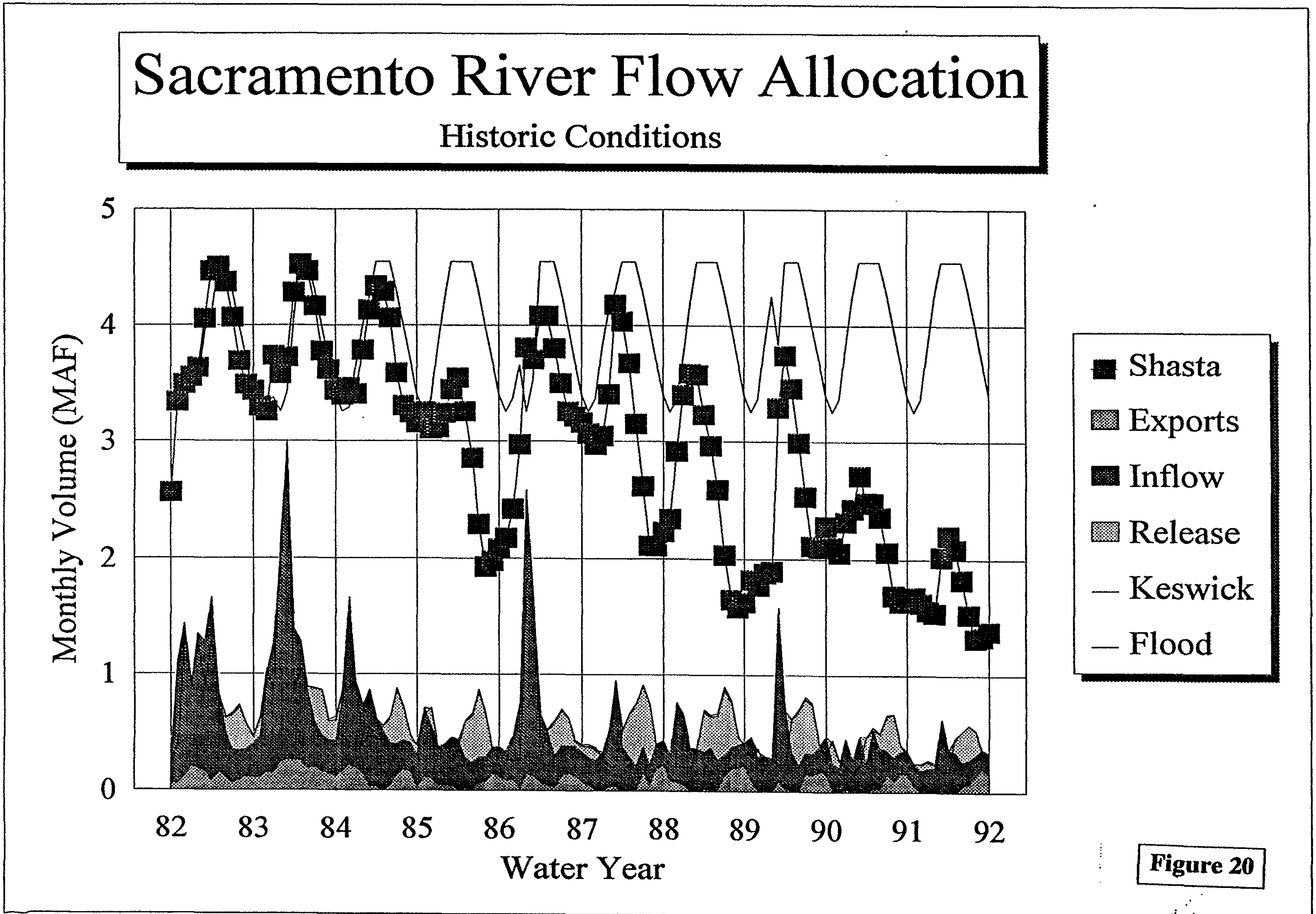
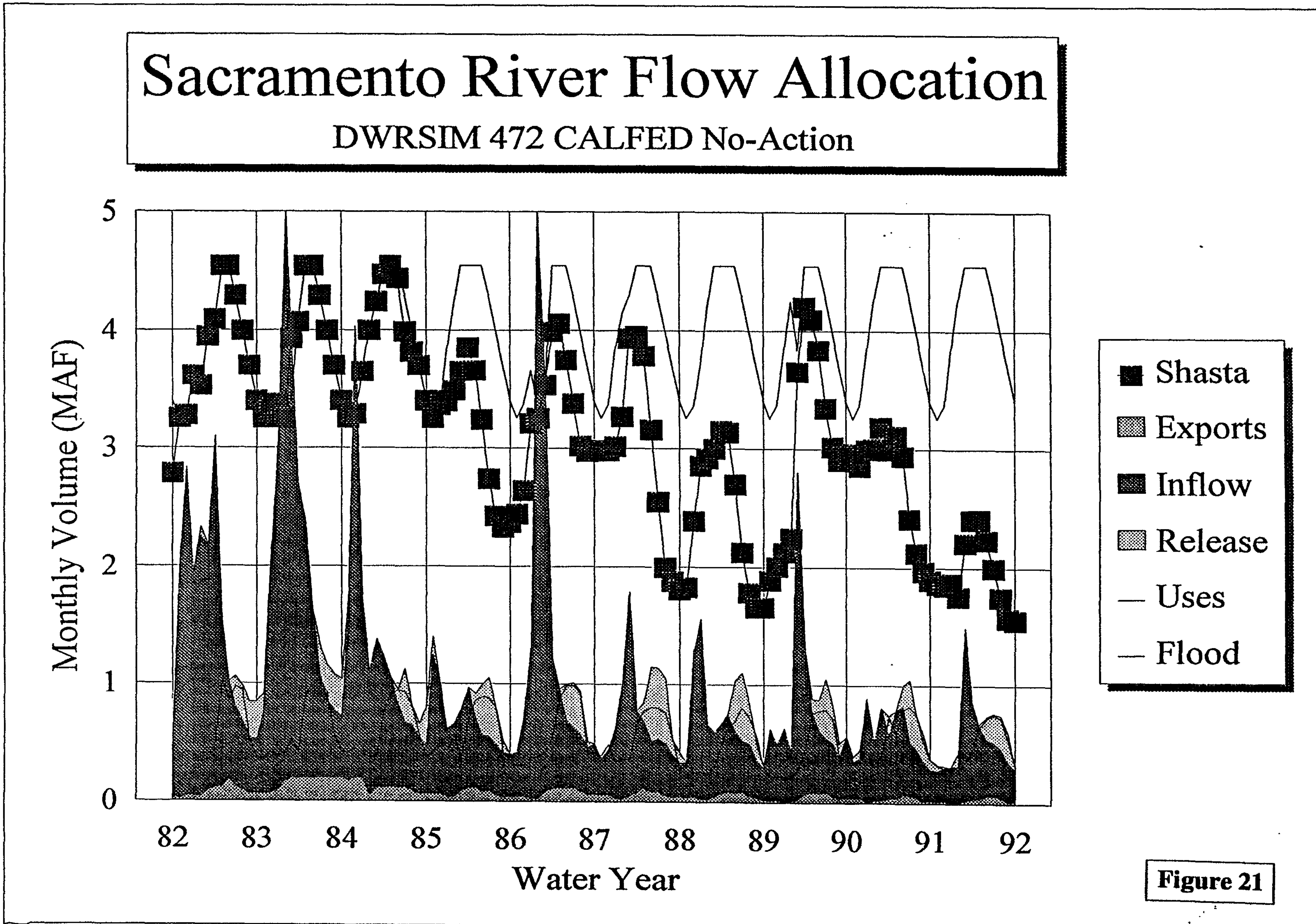


Figure 20

C-003252



C-003253

C—003253

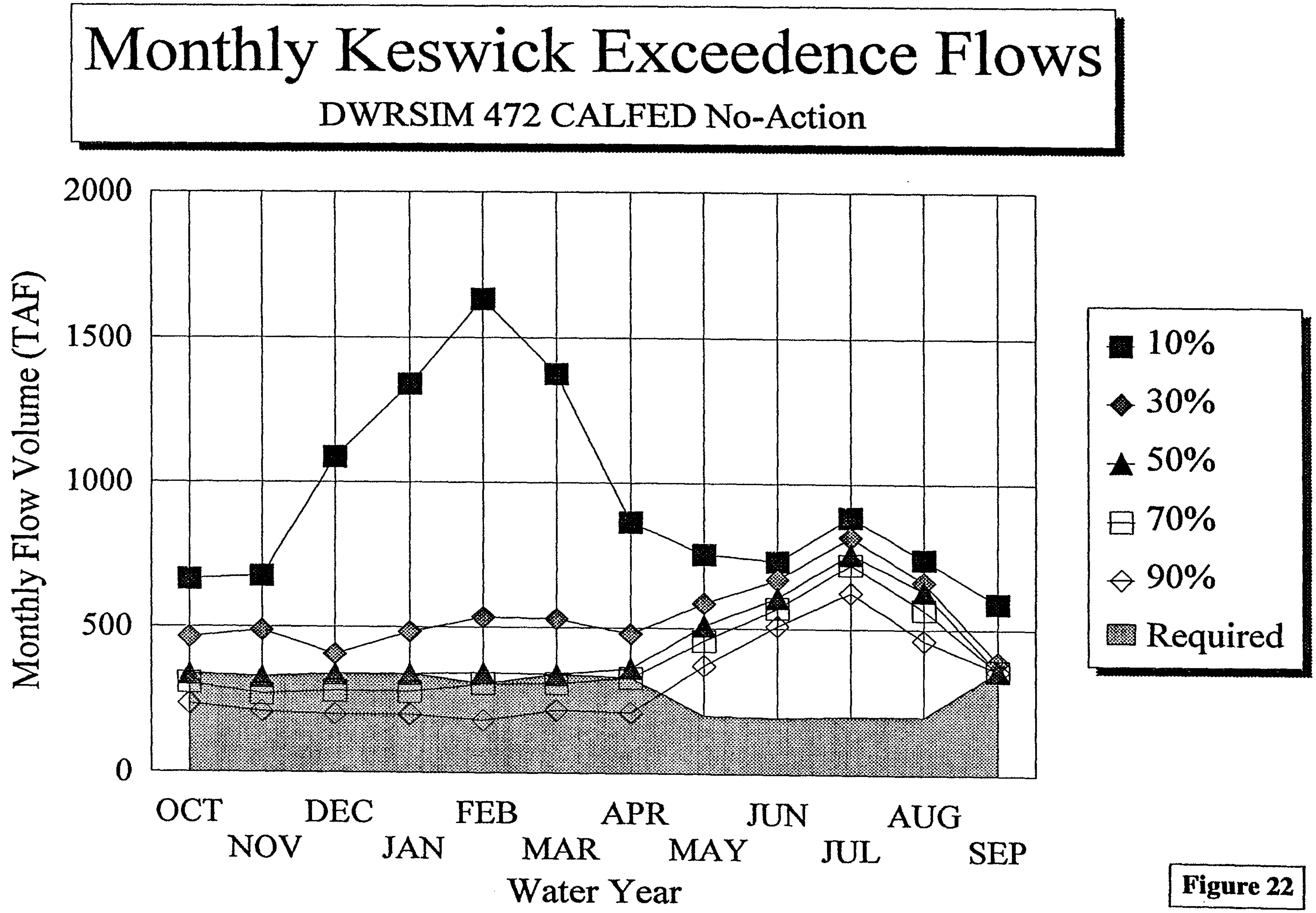


Figure 22

C-003254

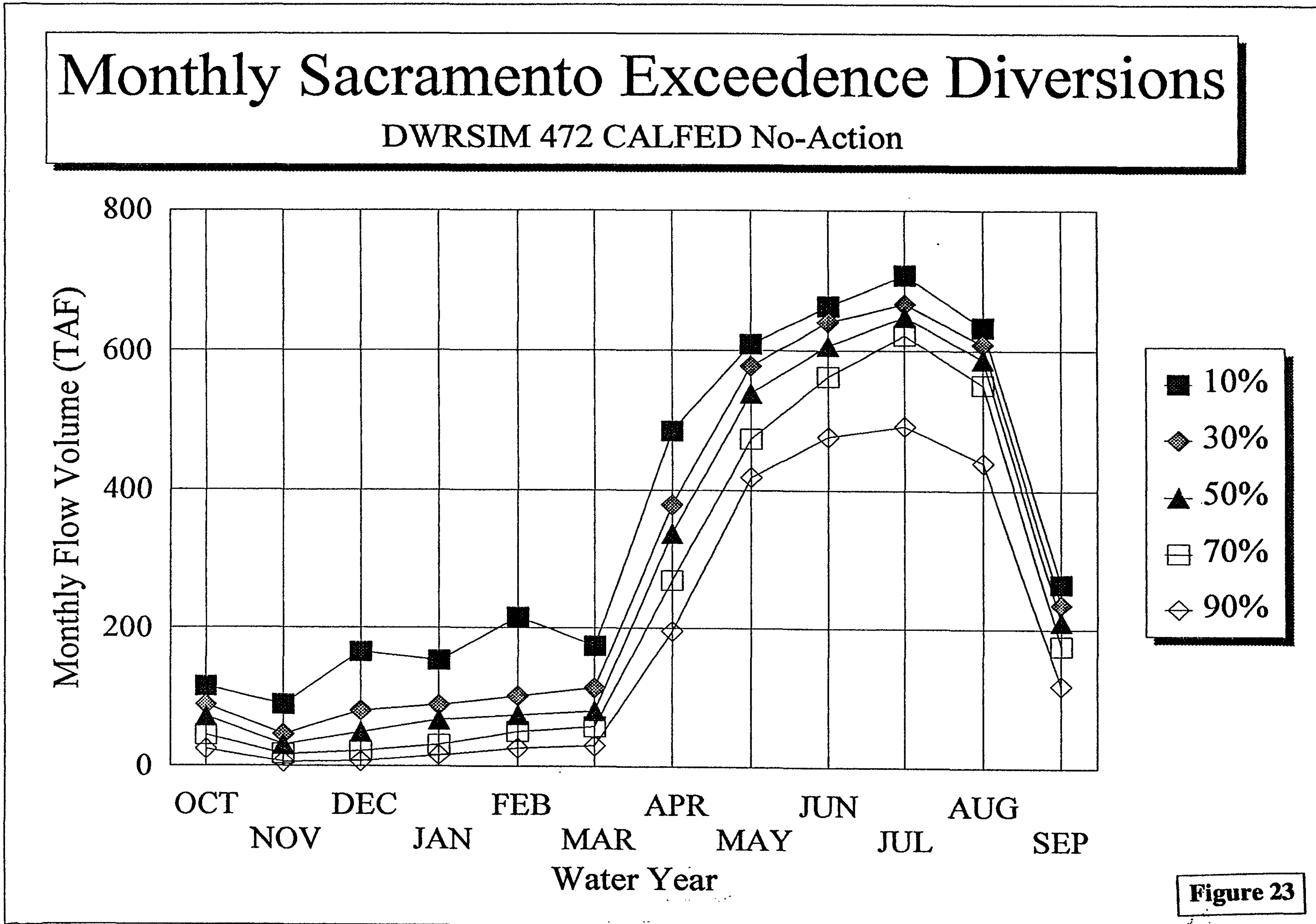


Figure 23

C-003255

C — 0 0 3 2 5 5

Monthly Navigation Exceedence Flows

DWRSIM 472 CALFED No-Action

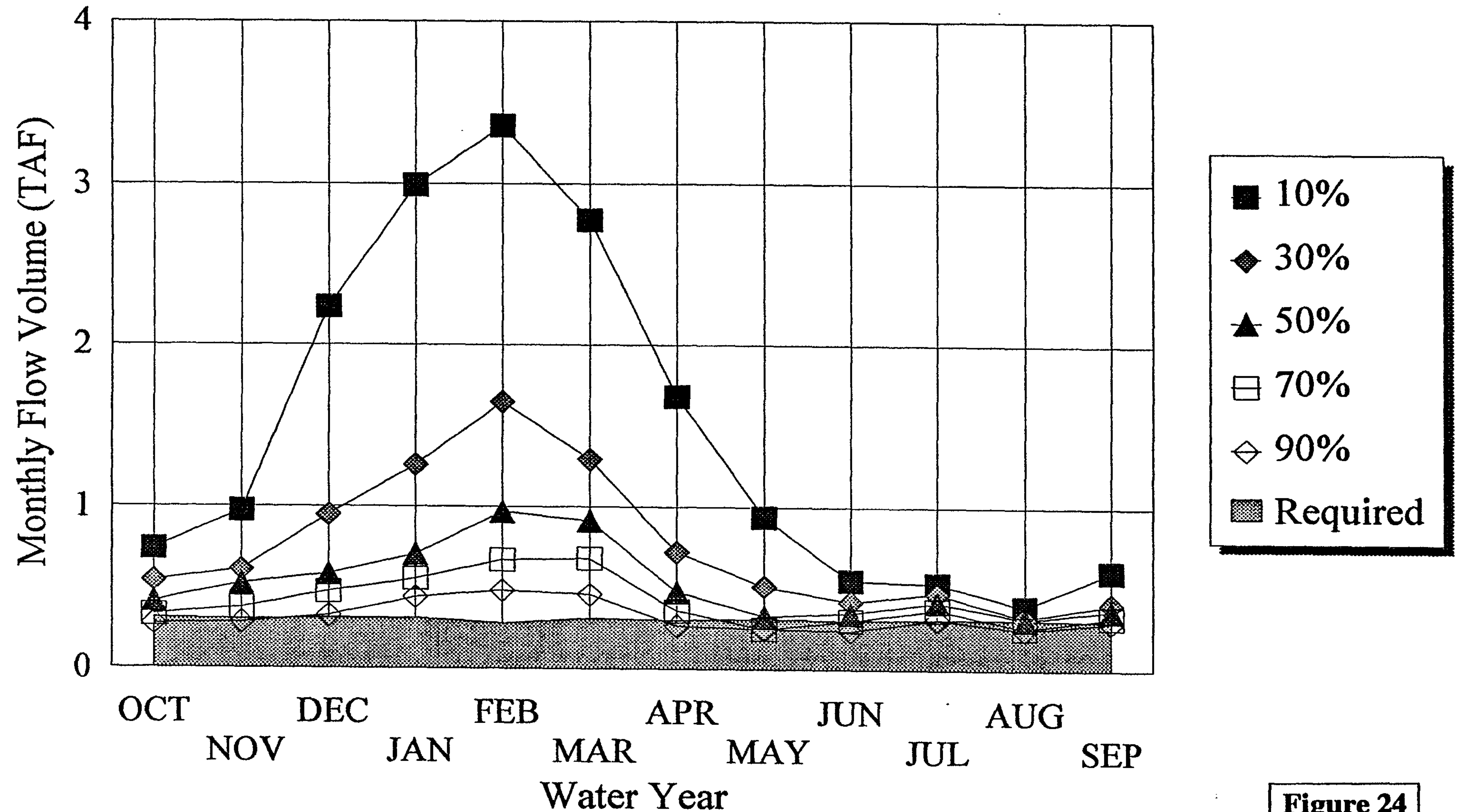


Figure 24

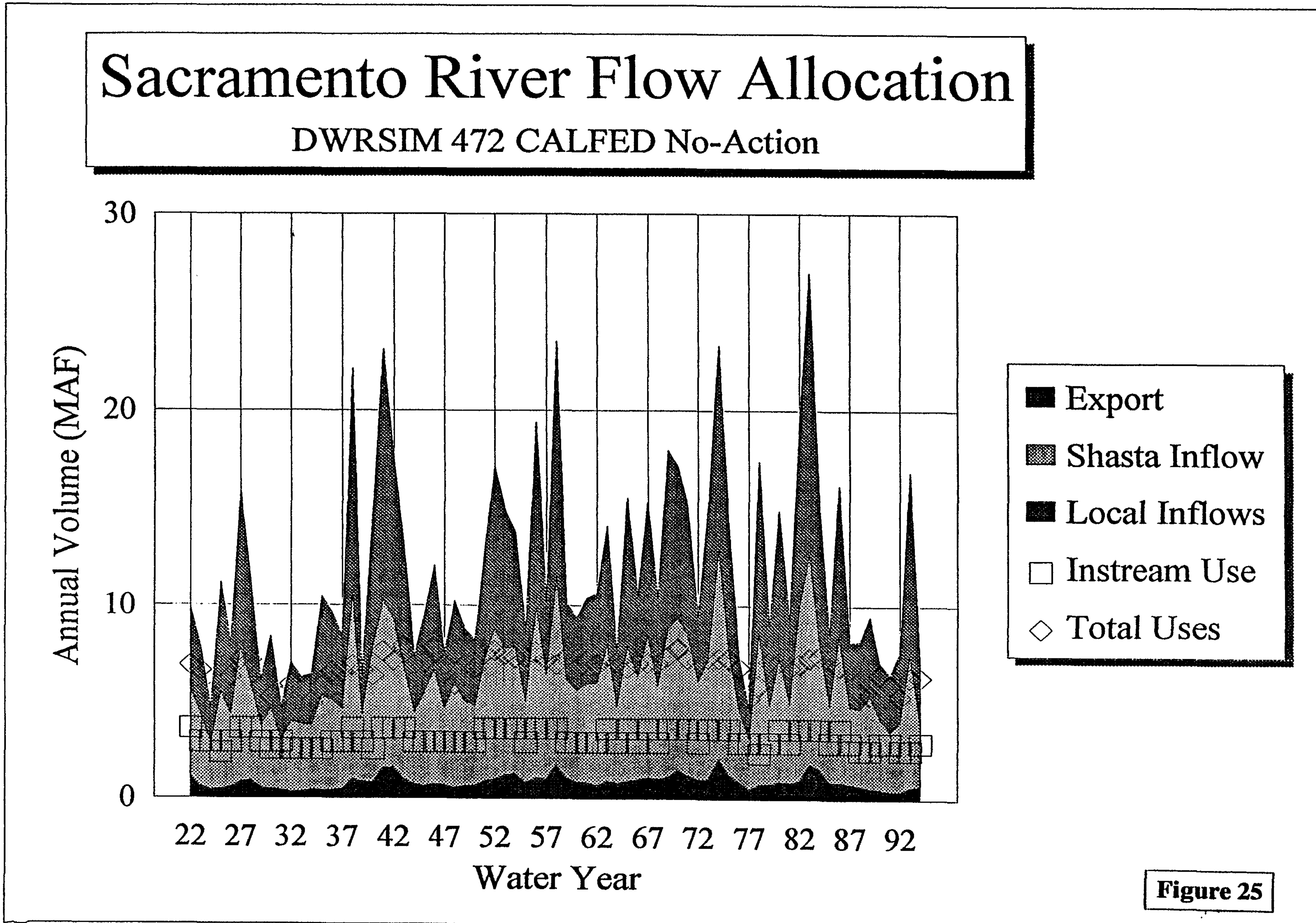


Figure 25

C-003257

Shasta Reservoir Carryover Storage

Historical and No-Action

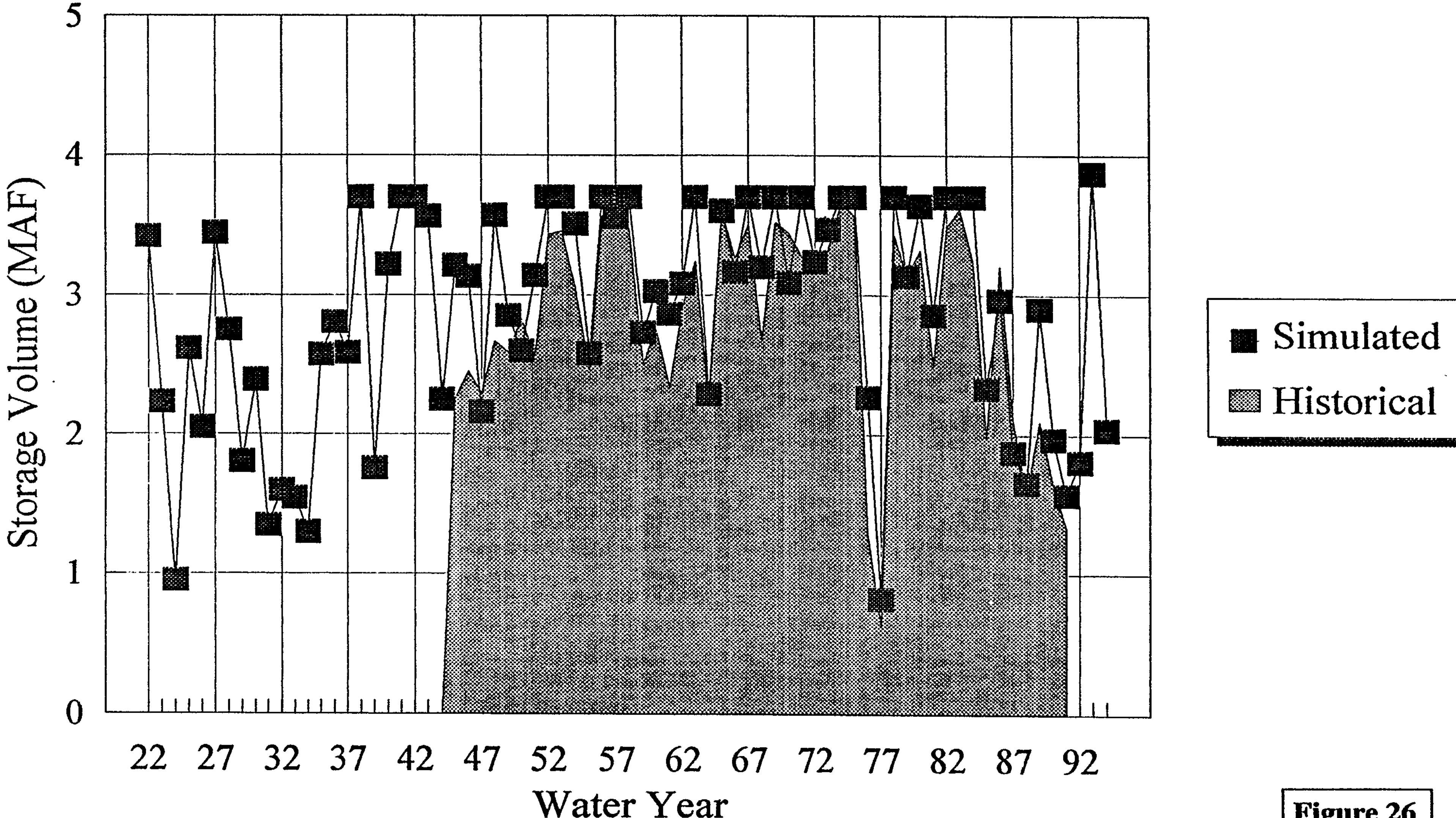


Figure 26

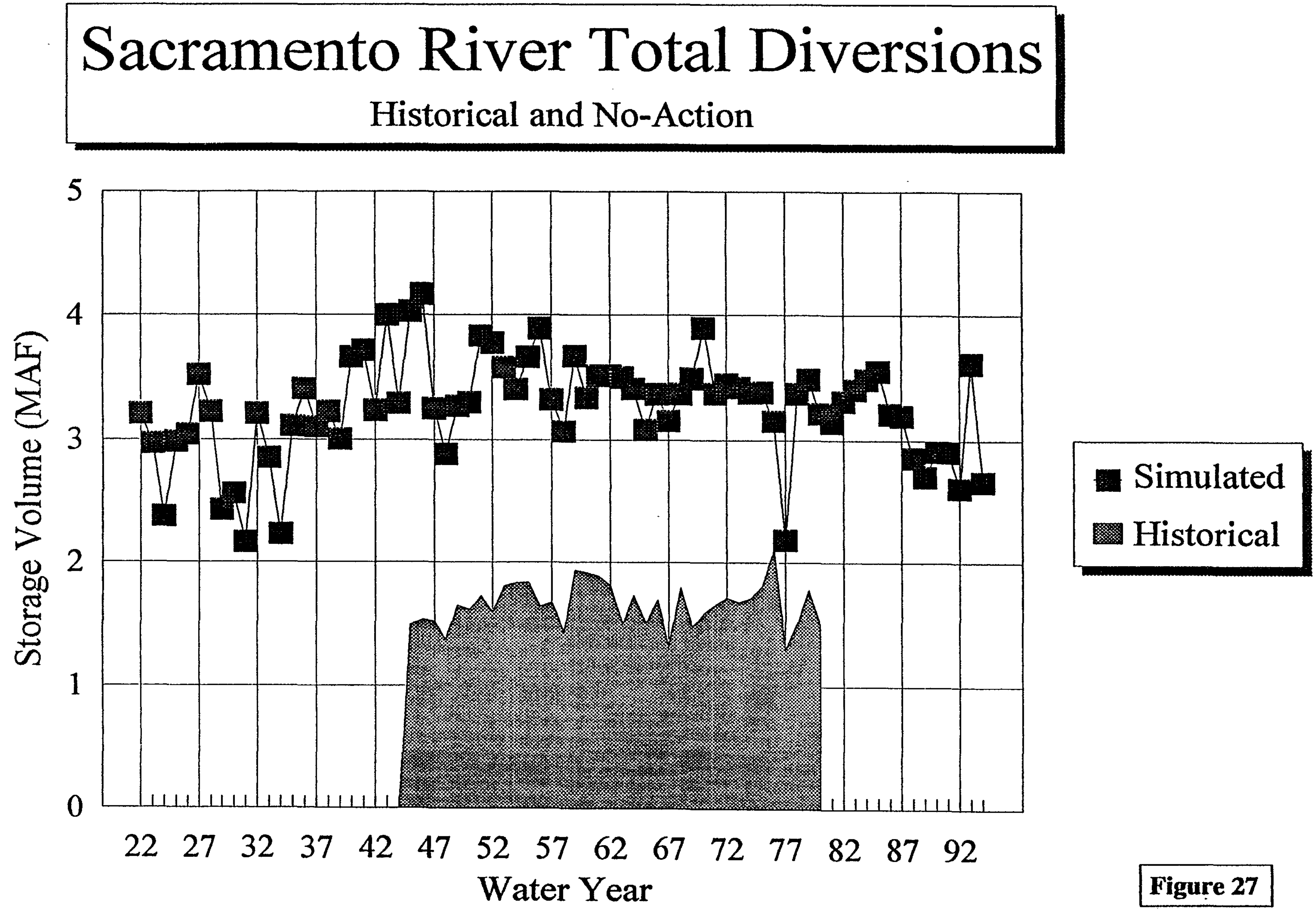


Figure 27

C-003259

Sacramento River Flow & Potential Diversions

DWRSIM 472 CALFED No-Action

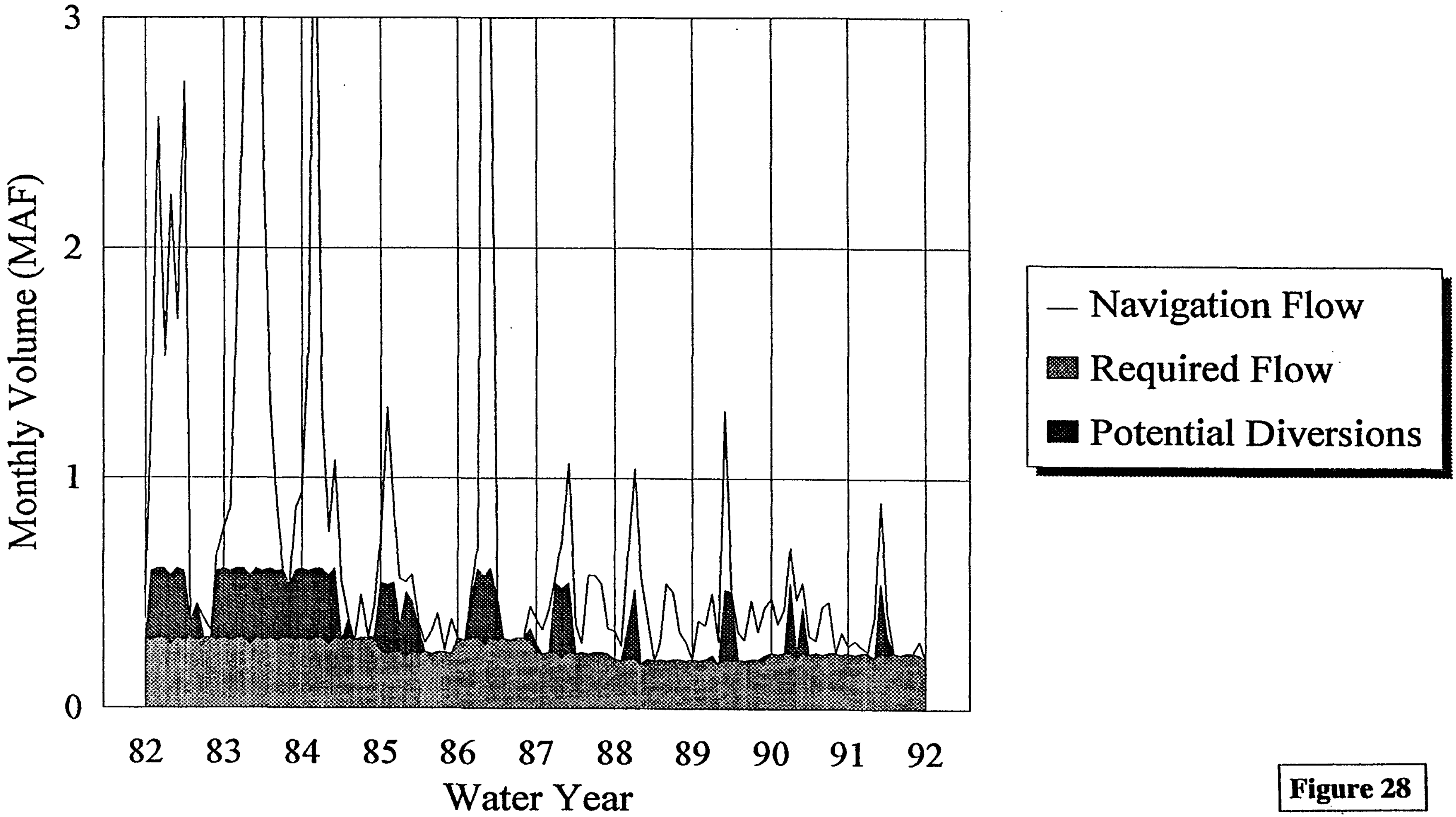


Figure 28

C-003260

Sacramento River Potential Diversions

DWRSIM 472 CALFED No-Action

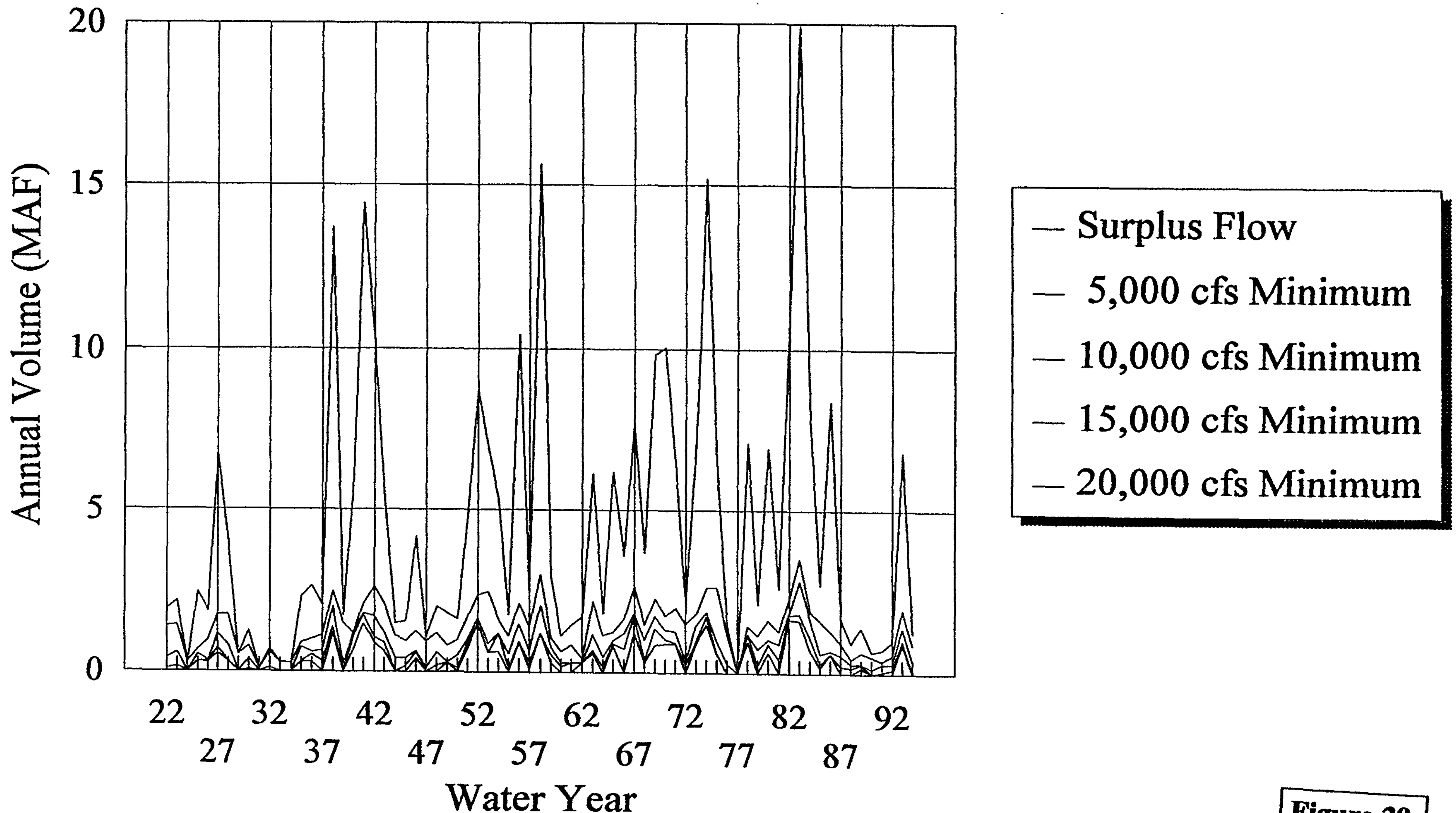


Figure 29

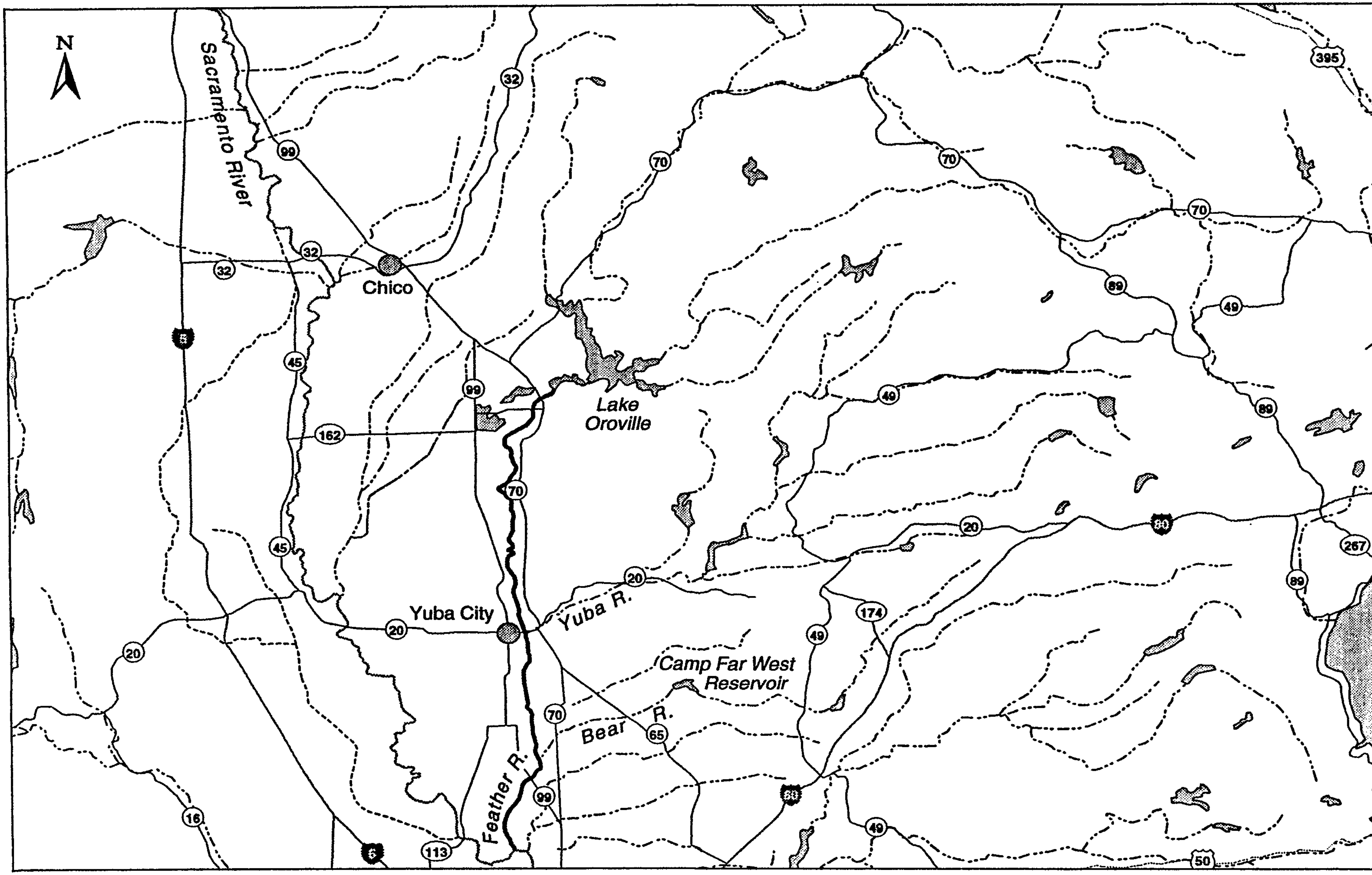


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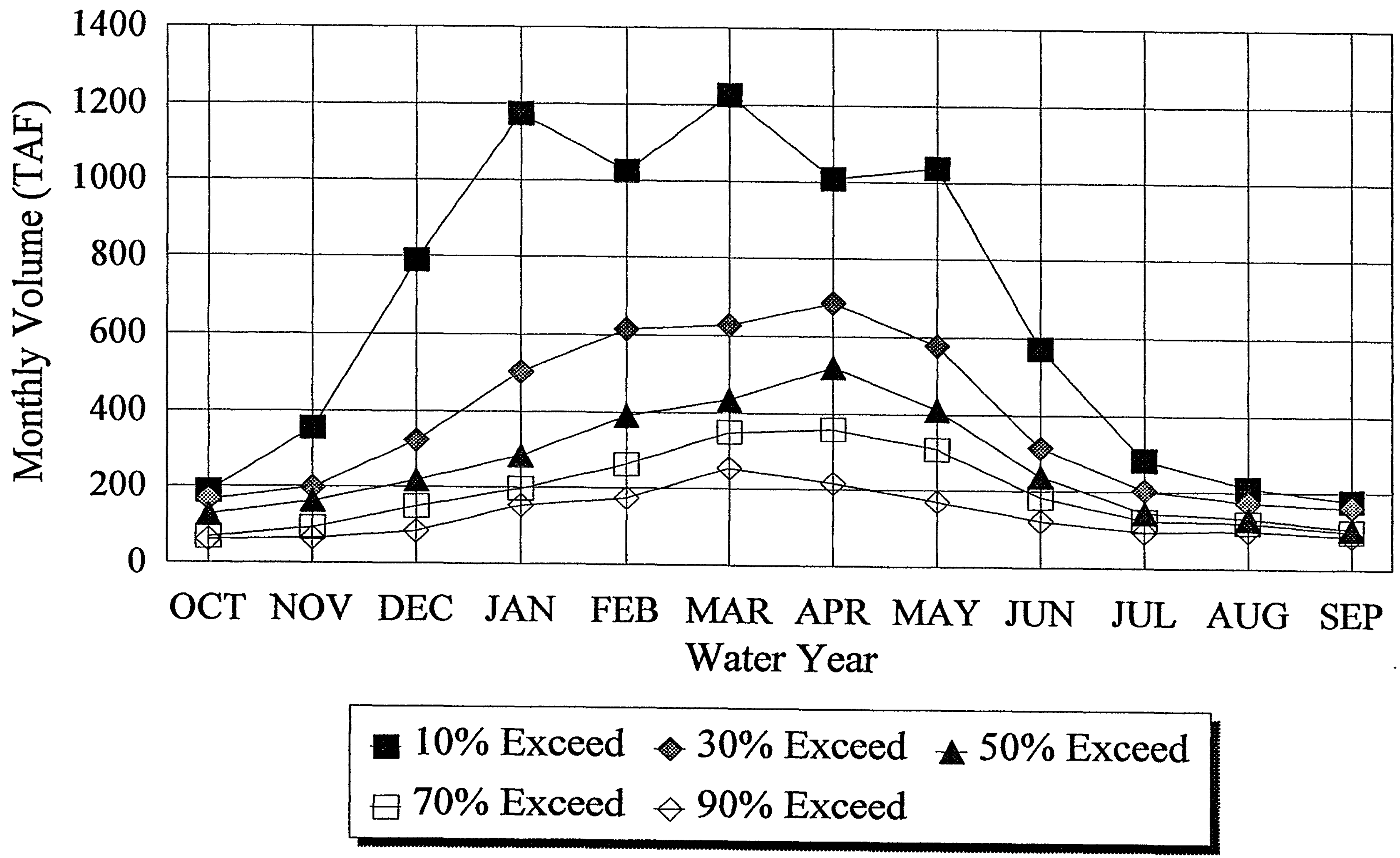
Figure 30
Feather River Basin Water Management Facilities

Figure 31

Feather River Inflow above the Thermalito Afterbay
(Estimated for DWRSIM 472 CALFED No-Action Alternative)



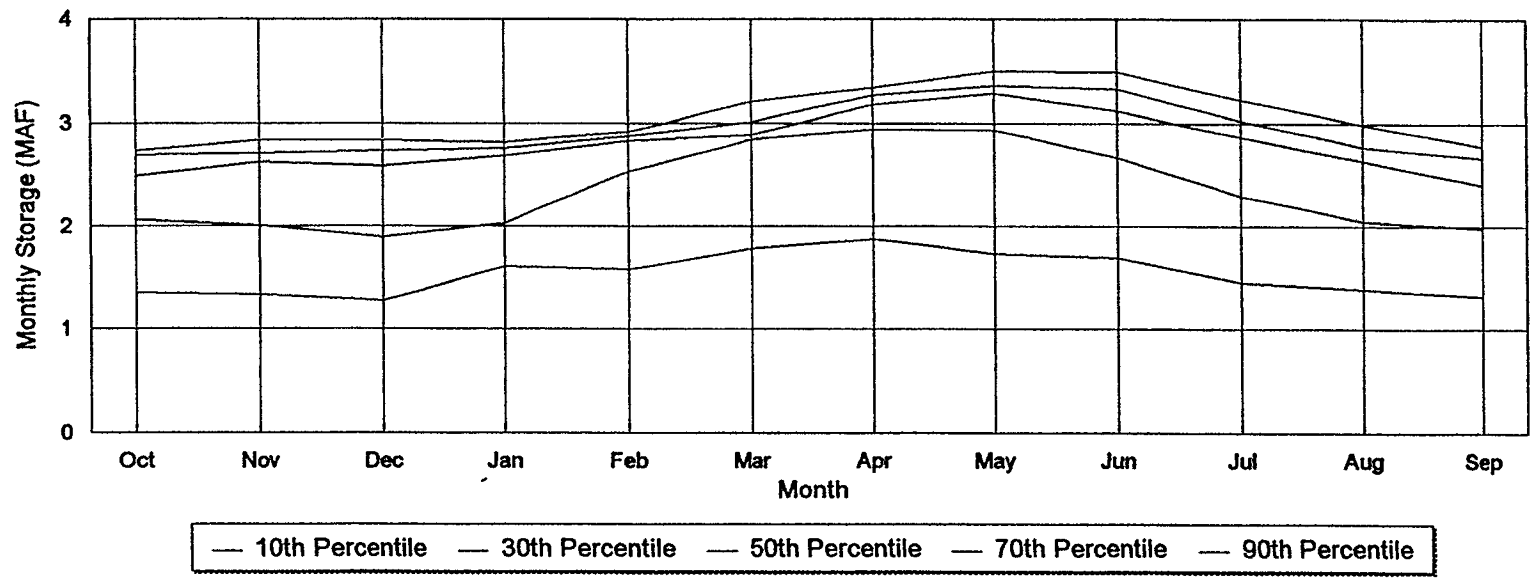
C-003263

C-003263

C-003264

Figure 32

Distribution of Historic End-of-Month Storage in Lake Oroville for Water Years 1972-1992



Historic End-of-Month Storage in Lake Oroville (TAF) for the 1972-1992 Period of Record
Average Storage = 2,501 TAF Drainage Area = 3,607 sq. mi. Data Source: CDEC

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	905	918	987	921	938	1320	1407	1353	1203	997	892	915
10%	1353	1331	1266	1606	1572	1775	1871	1728	1693	1450	1388	1317
20%	1743	1686	1660	1700	1935	2662	2553	2479	2239	1868	1645	1529
30%	2066	2008	1889	2030	2525	2835	2935	2928	2662	2290	2053	1979
40%	2146	2125	2388	2584	2744	2860	3127	3253	3093	2628	2284	2150
50%	2484	2619	2583	2679	2822	2880	3175	3288	3118	2861	2633	2397
60%	2594	2681	2653	2719	2848	2982	3223	3344	3235	2945	2757	2611
70%	2687	2707	2732	2754	2869	3010	3274	3364	3329	3022	2766	2661
80%	2728	2752	2812	2778	2888	3078	3315	3442	3389	3139	2795	2729
90%	2732	2830	2831	2813	2911	3207	3344	3502	3490	3225	2984	2775
100%	2809	2891	2861	2881	3087	3326	3424	3515	3513	3318	3036	2858

Figure 33

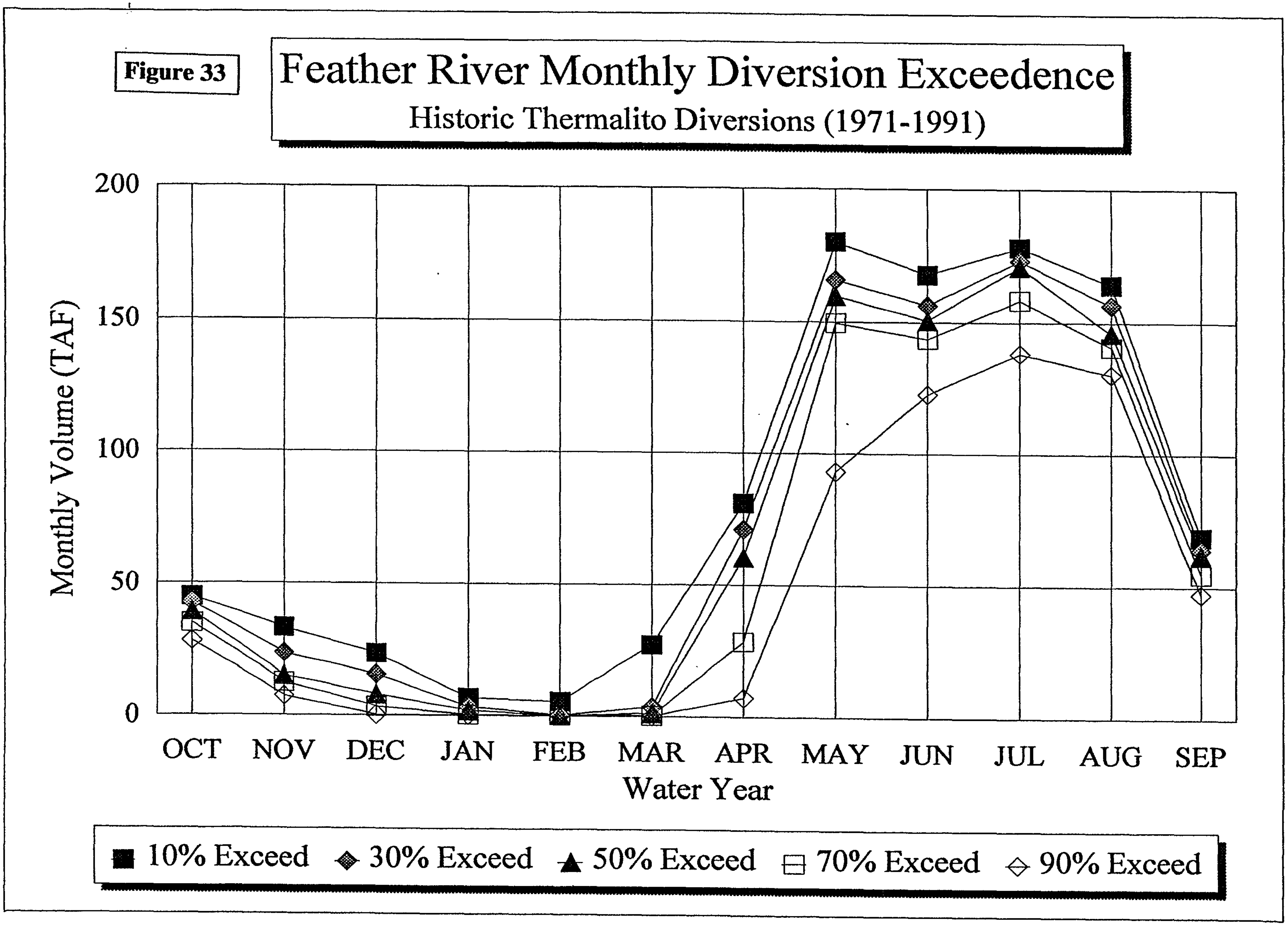
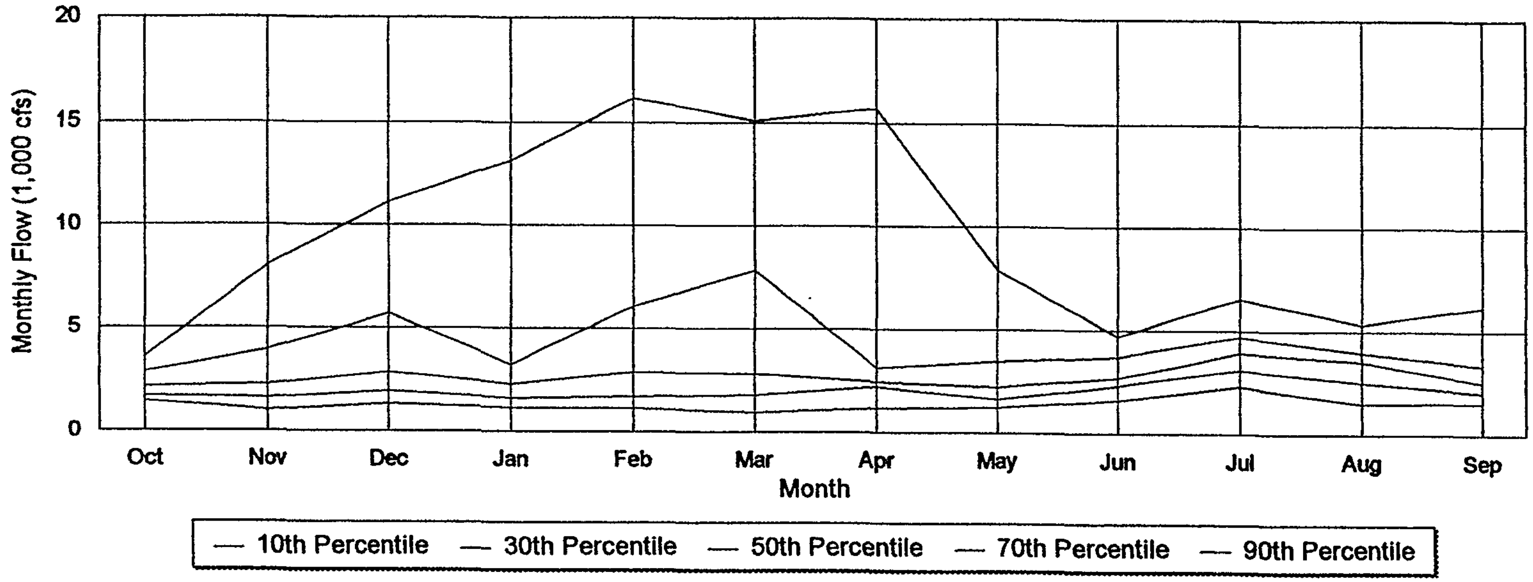

Feather River Monthly Diversion Exceedence
Historic Thermalito Diversions (1971-1991)
200
150
100
50
0
Monthly Volume (TAF)
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Water Year
10% Exceed
30% Exceed
50% Exceed
70% Exceed
90% Exceed

Figure 34

Distribution of Historic Monthly Flows in the Feather River at Gridley for Water Years 1972-1992



Historic Monthly Flow in the Feather River at Gridley (cfs) for the 1972-1992 Period of Record
Average Flow = 4,435 cfs **Drainage Area = 3,676 sq. mi.** **Data Source: USGS**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	853	855	832	936	905	895	804	809	913	1,812	1,059	1,002	1,009
10%	1,422	1,006	1,284	1,100	1,105	930	1,140	1,203	1,616	2,283	1,472	1,506	1,150
20%	1,503	1,413	1,431	1,218	1,227	1,659	1,514	1,335	1,734	2,654	2,410	1,684	1,631
30%	1,694	1,604	1,937	1,593	1,686	1,782	2,193	1,655	2,296	3,089	2,485	2,030	1,830
40%	1,863	1,952	2,429	1,688	2,144	2,325	2,331	2,040	2,544	3,664	3,026	2,259	2,101
50%	2,127	2,217	2,823	2,263	2,838	2,792	2,417	2,181	2,673	3,904	3,532	2,480	2,171
60%	2,772	2,351	4,955	2,998	4,455	4,572	2,634	2,859	3,102	4,235	3,644	2,844	2,348
70%	2,848	3,894	5,699	3,231	6,064	7,829	3,112	3,469	3,666	4,709	3,926	3,351	3,470
80%	3,077	4,921	6,692	12,981	9,725	9,962	5,515	4,288	4,468	5,199	4,633	3,726	4,924
90%	3,573	8,038	11,109	13,129	16,150	15,076	15,673	7,898	4,716	6,553	5,308	6,177	7,301
100%	6,520	12,941	22,703	23,388	34,168	33,529	22,627	12,598	9,996	7,145	7,565	7,872	8,603

Figure 35 Historic Feather River Flow Allocation above the Yuba River

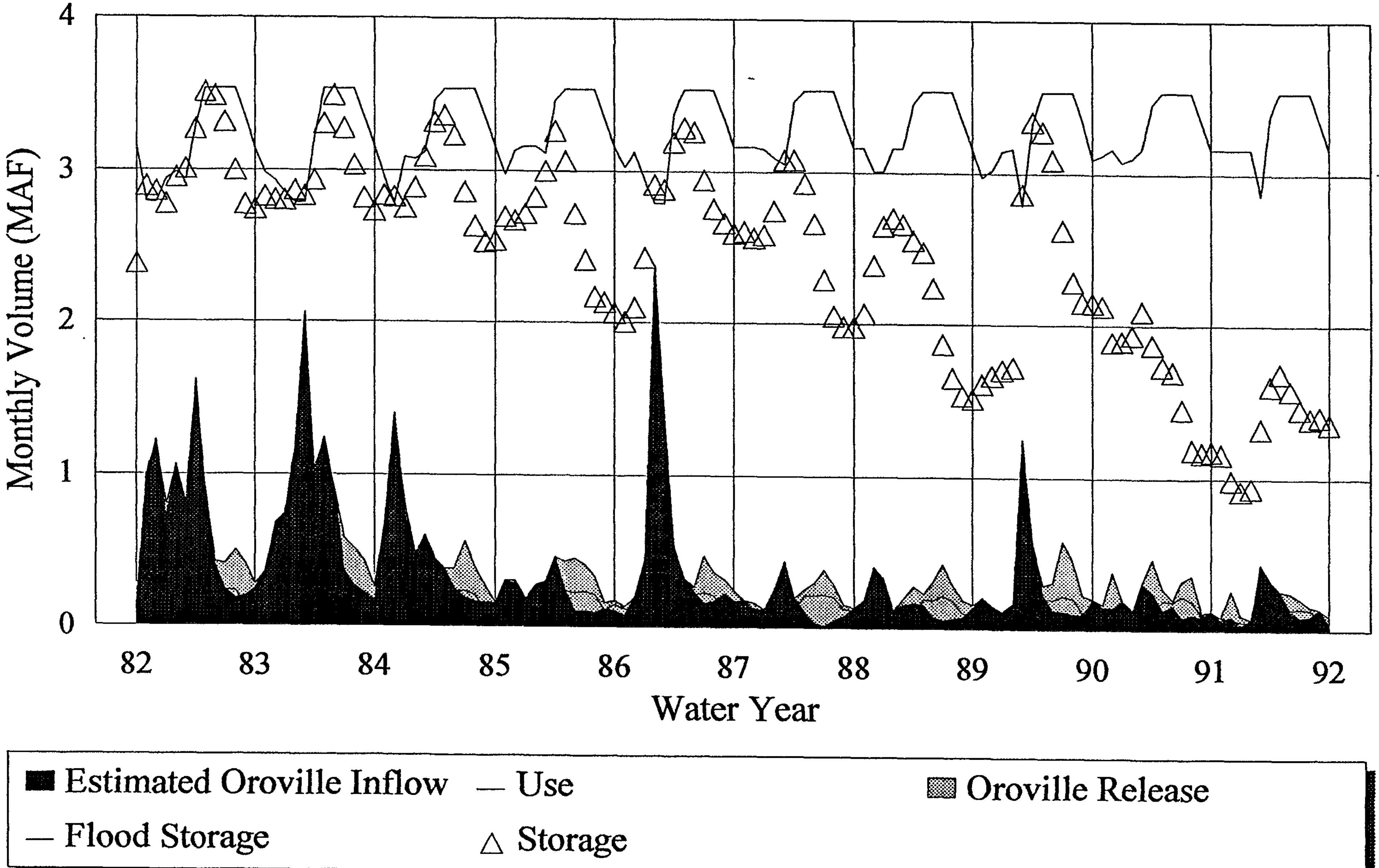
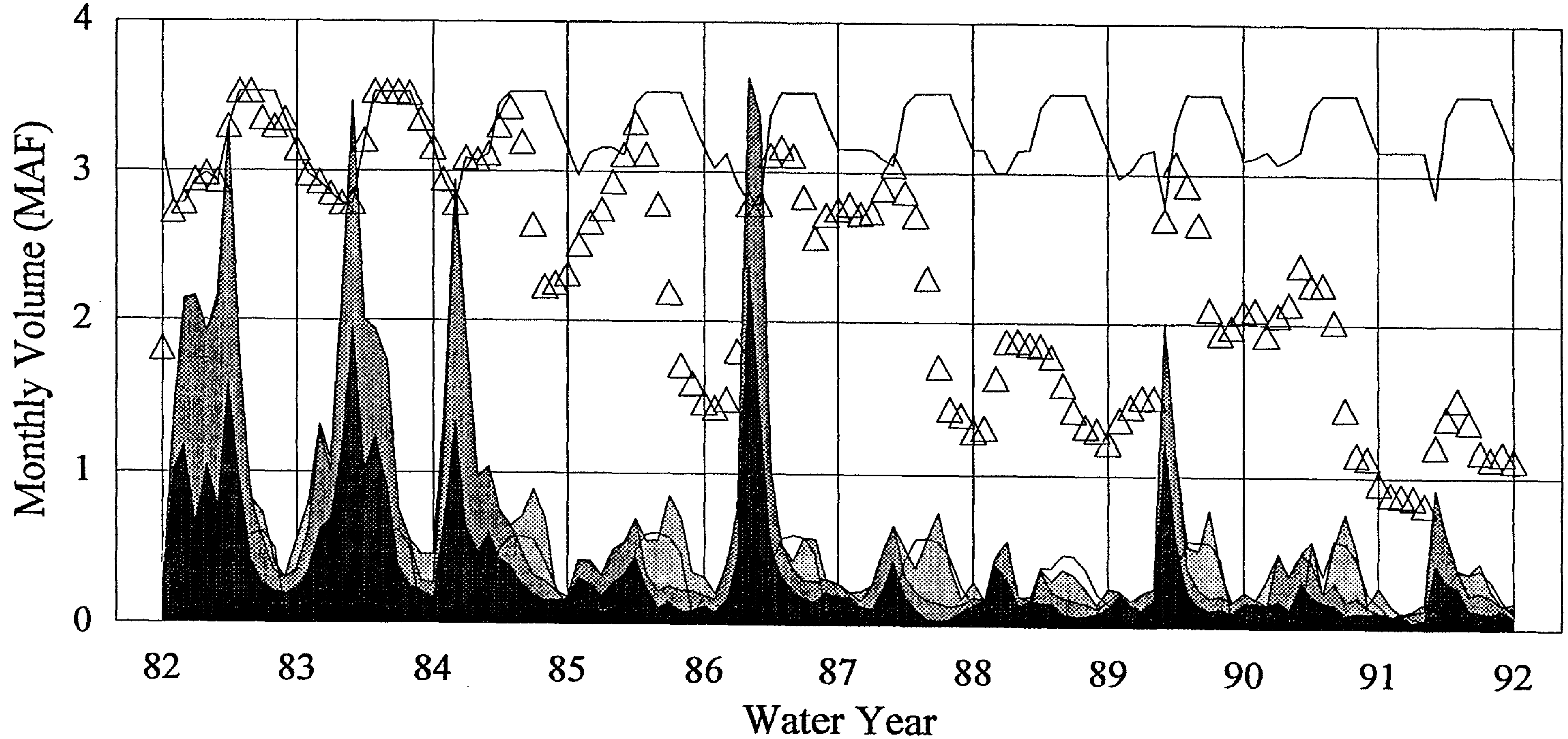


Figure 36

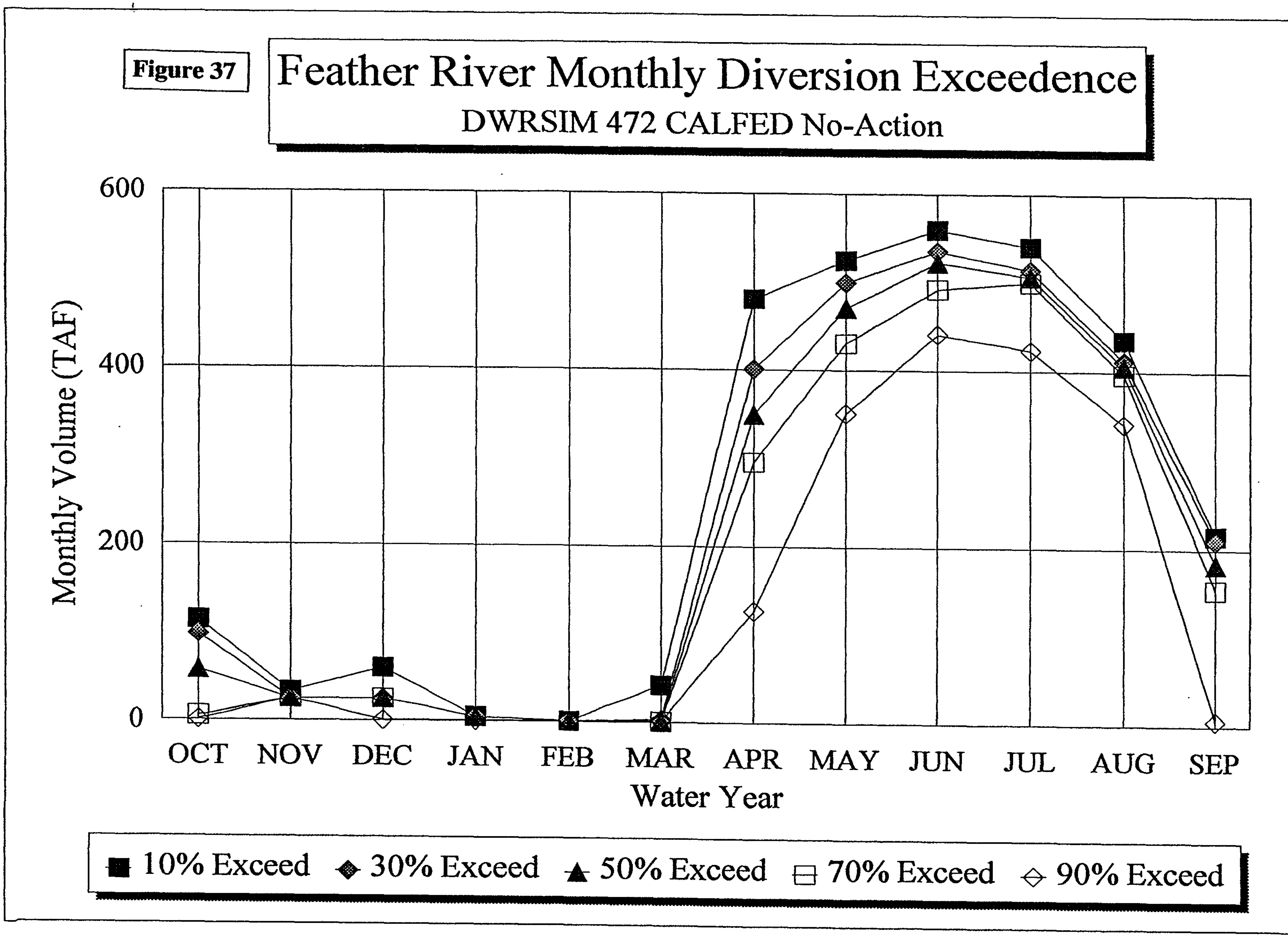
Feather River Flow Allocation

DWRSIM 472 CALFED No-Action



C — 0 0 3 2 6 8

Figure 37



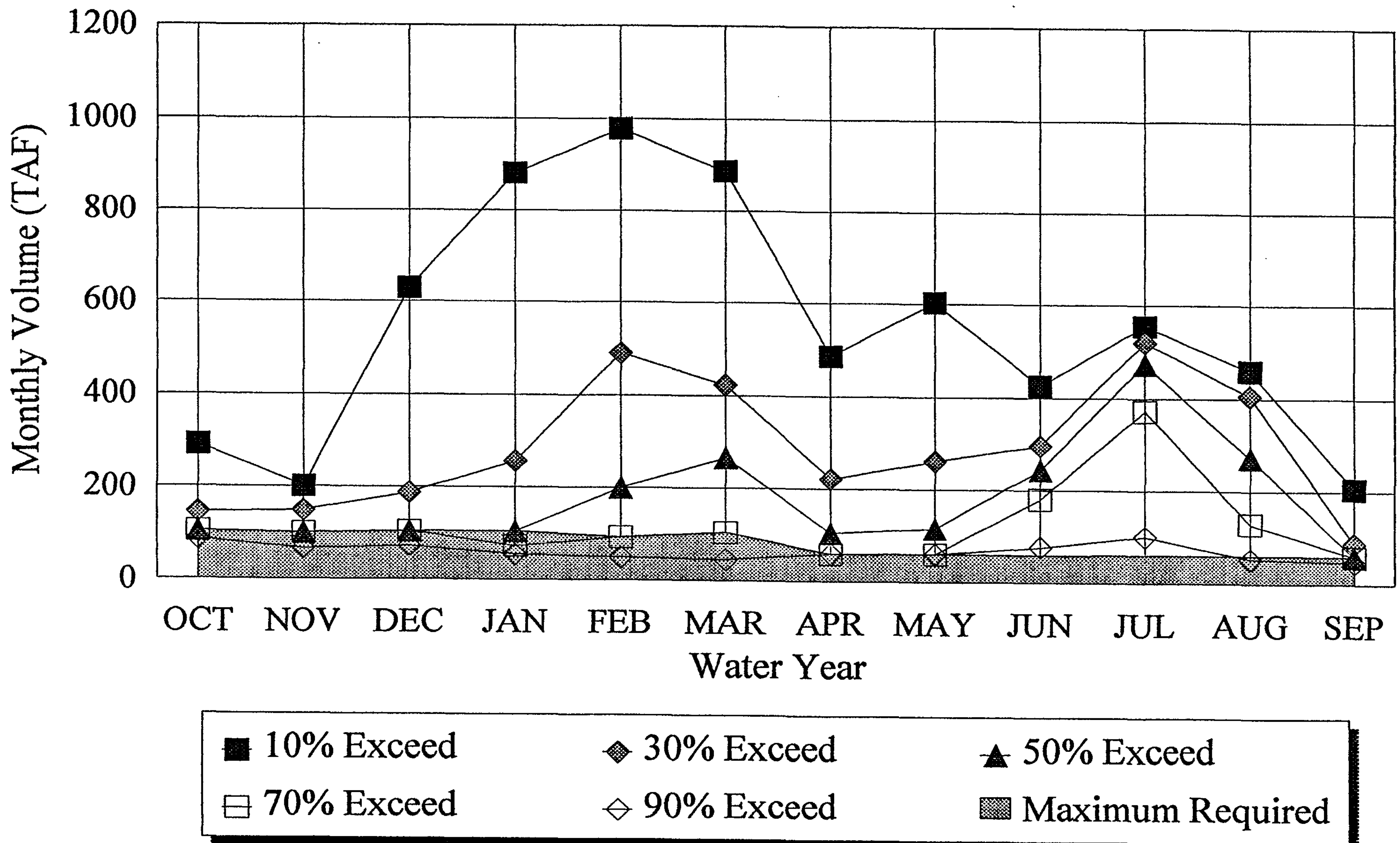
C-003269

C-003269

Figure 38

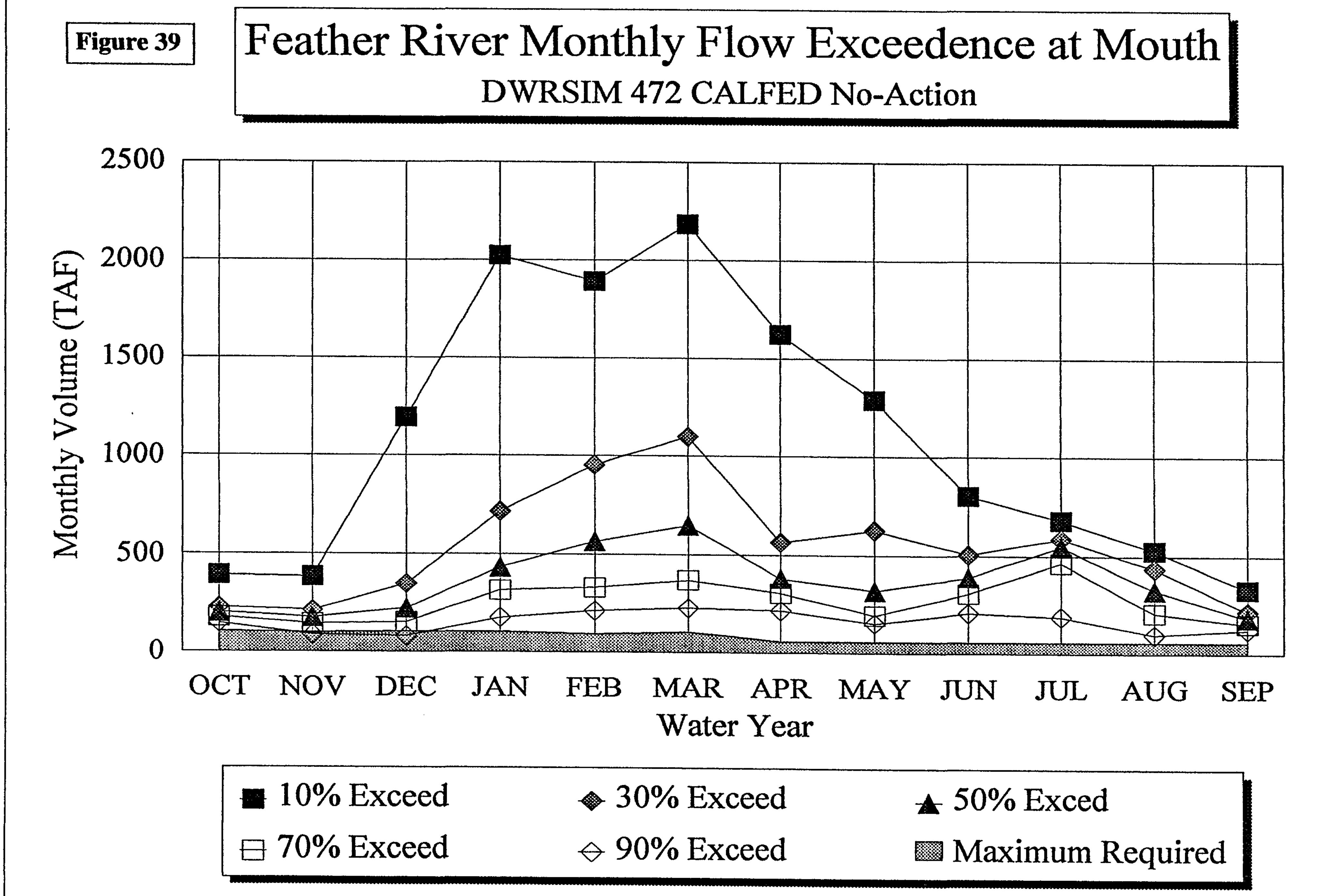
Feather River Monthly Flow Exceedence at Gridley

DWRSIM 472 CALFED No-Action



C-003270

Figure 39



C-003271

Figure 40

Feather/Yuba/Bear River Annual Water Allocation

No-Action Alternative

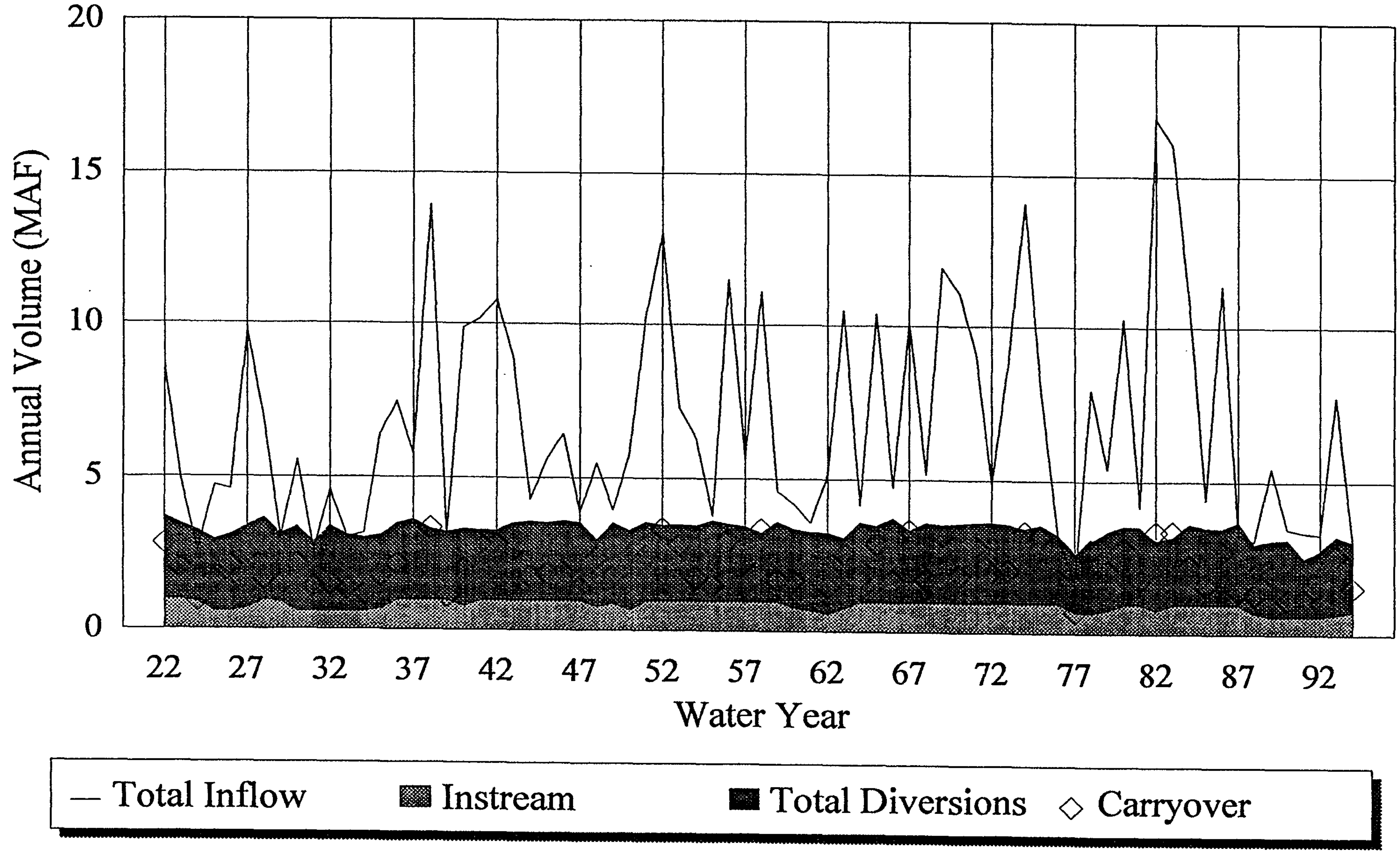
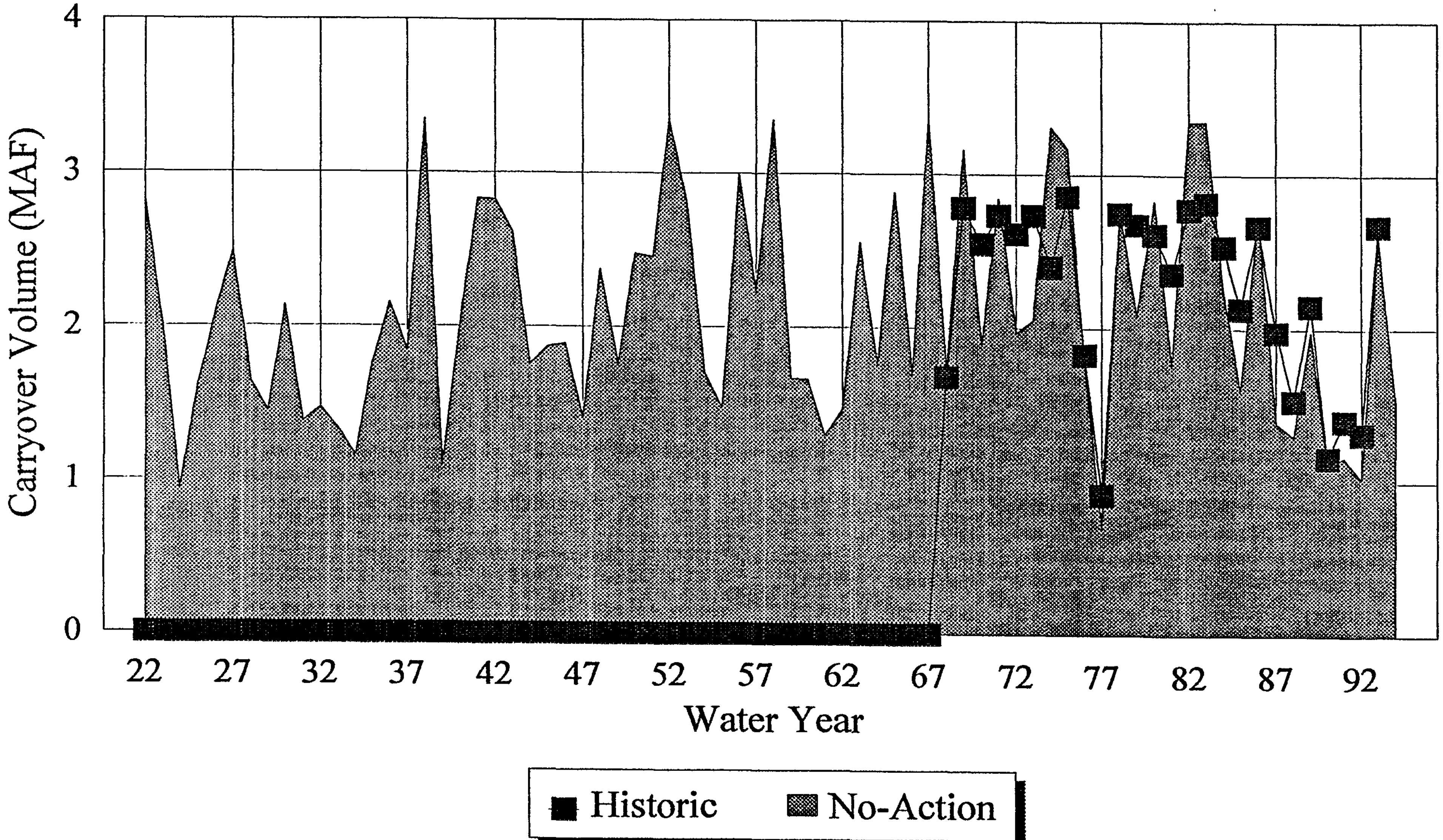


Figure 41

Lake Oroville Carryover Storage

Historical and No-Action

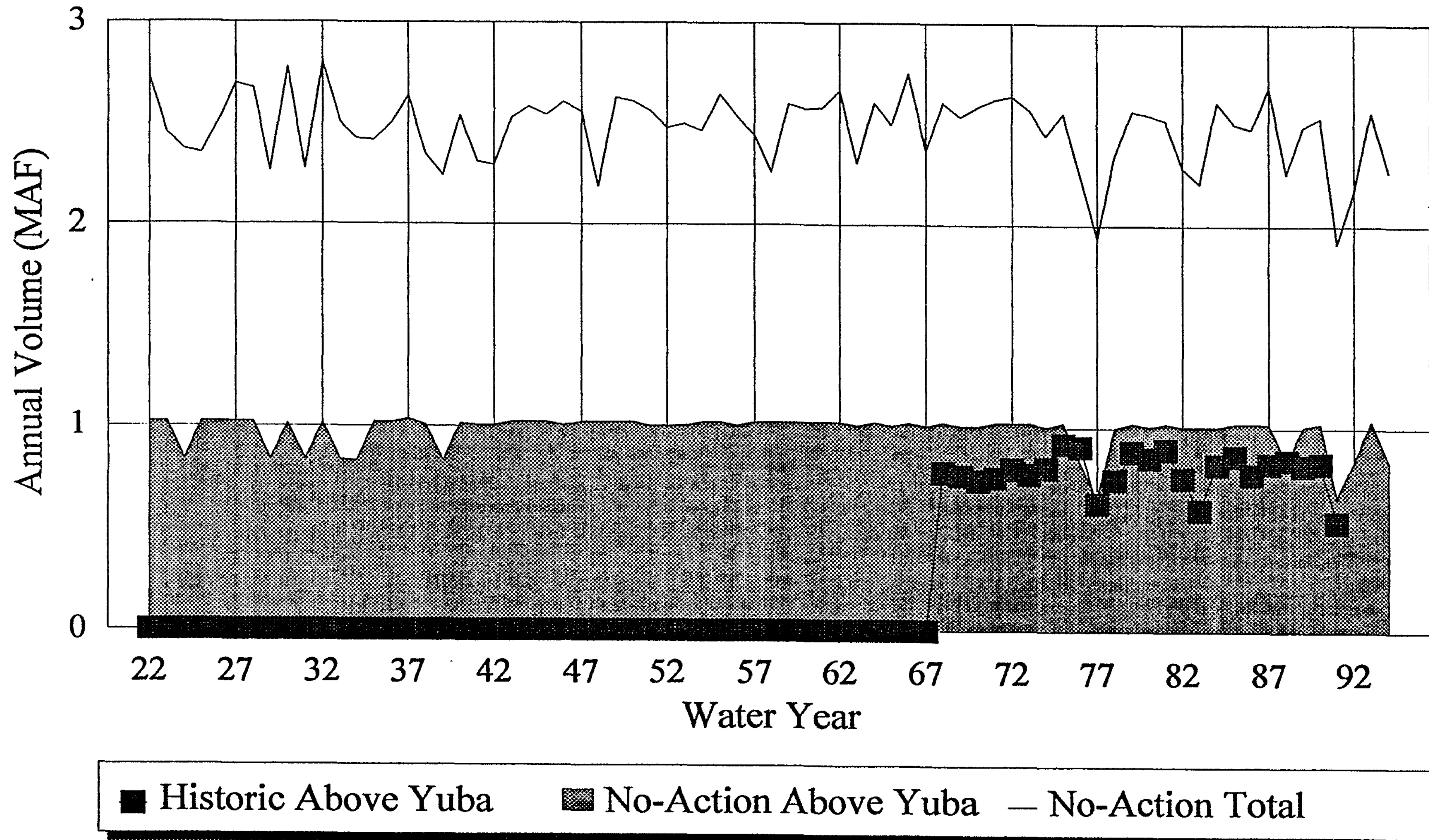


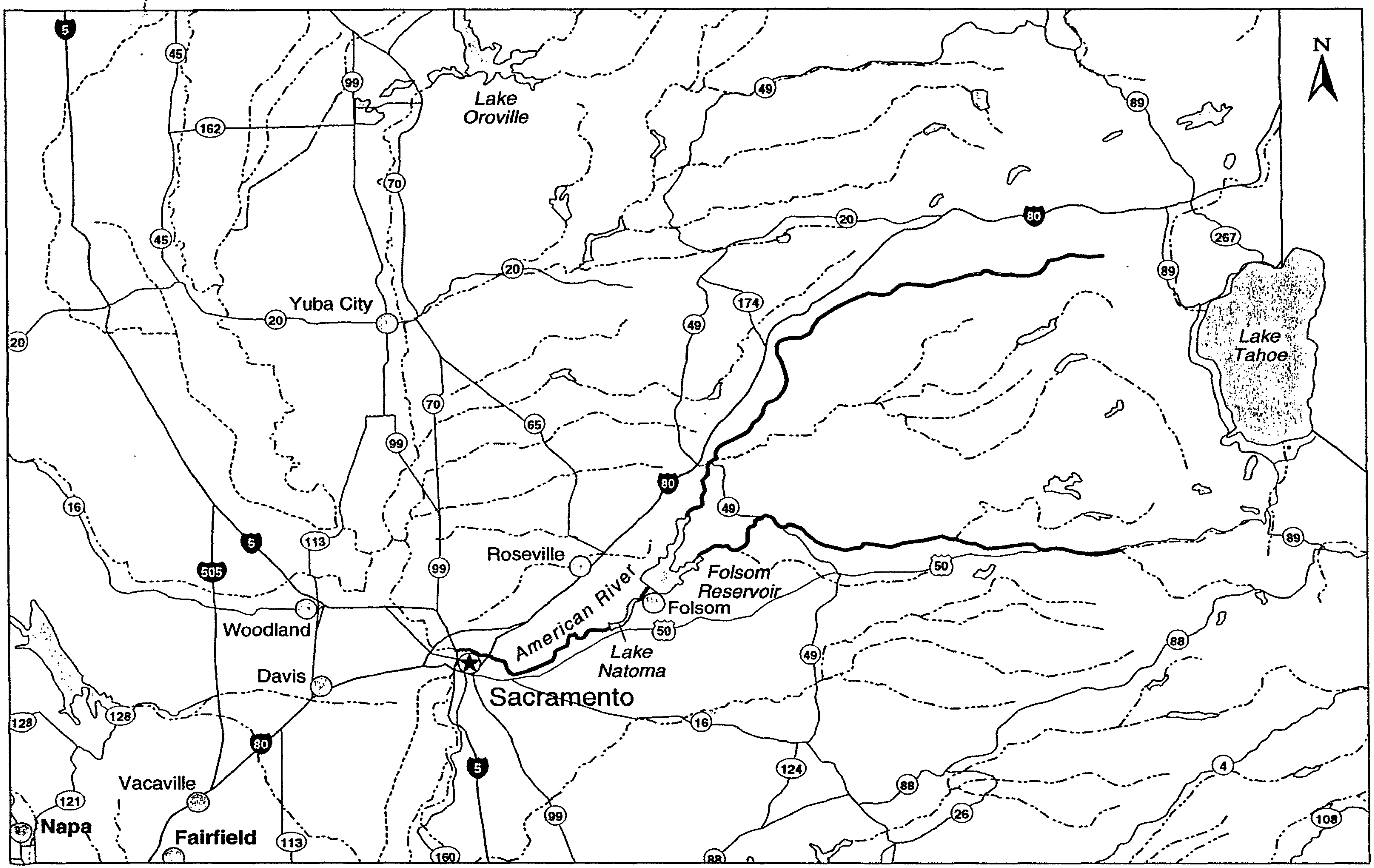
C-003273

Figure 42

Feather River Diversions

Historical and No-Action





CALFED BAY-DELTA PROGRAM

Figure 43
American River Basin Water Management Facilities

C-003275

American River Inflow above Nimbus Dam

(Estimated for DWRSIM 472 CALFED No-Action Alternative)

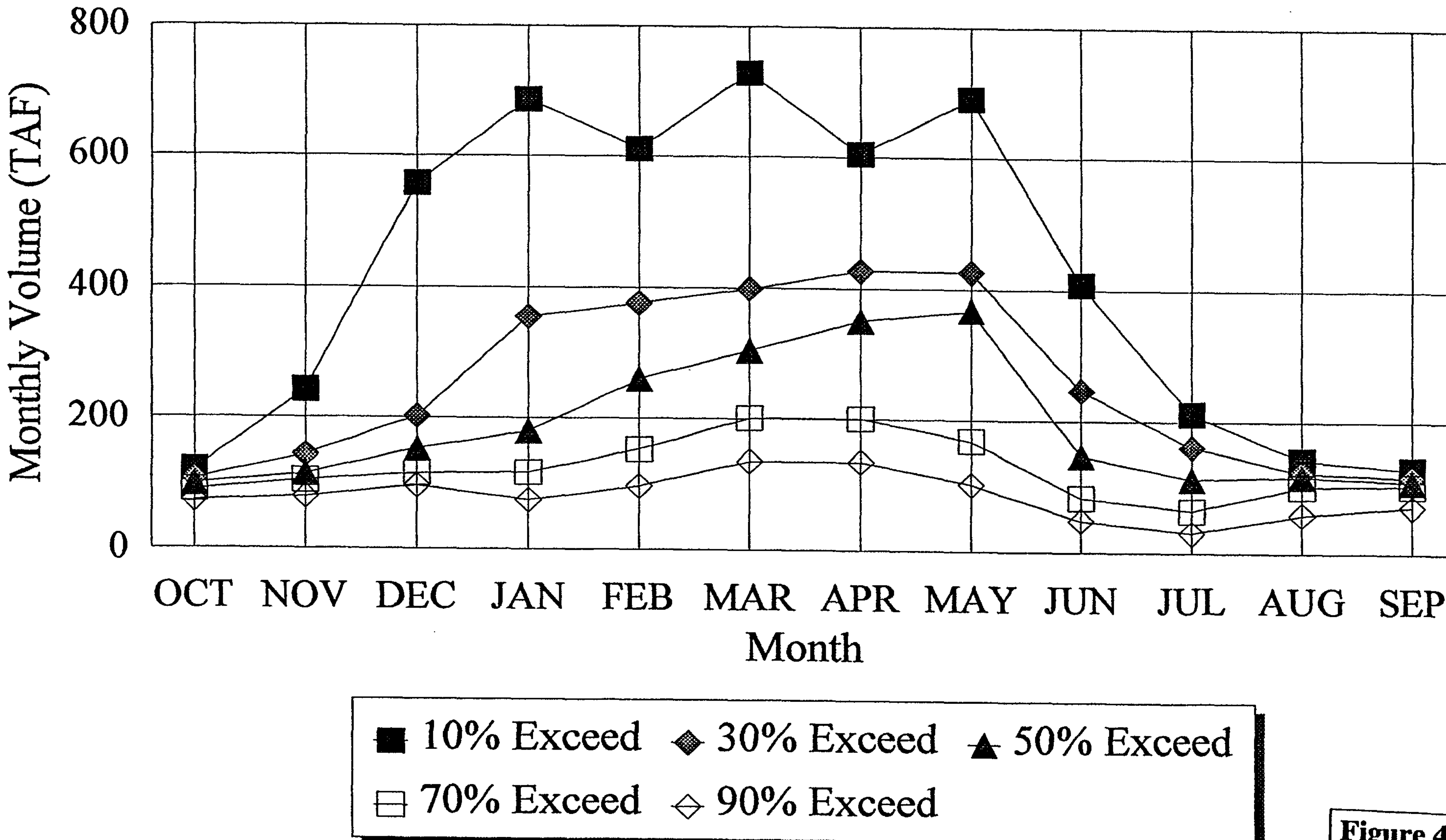
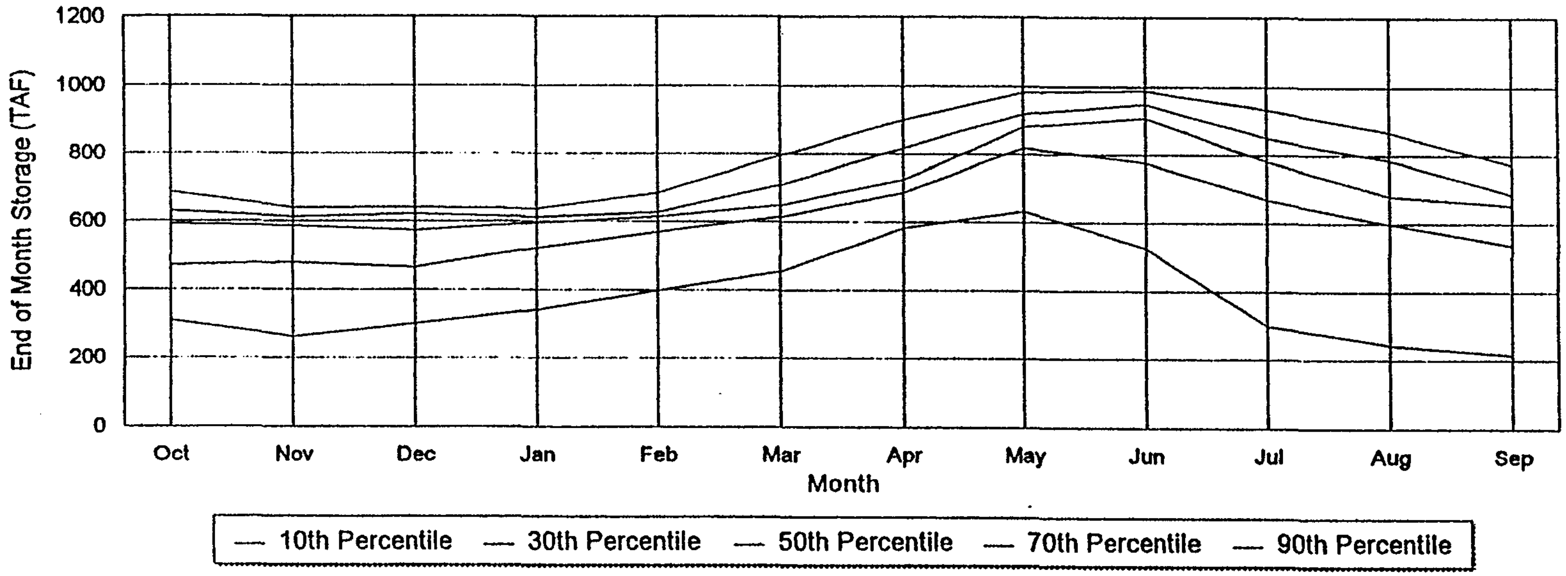


Figure 44

Figure 45

Distribution of End of Month Storage in Folsom Lake for Water Years 1962-1992



End of Month Storage in Folsom Lake (TAF) for the 1962-1992 Period of Record
Average Storage = 637 TAF **Drainage Area = 1,861 sq. mi.** **Data Source: CDEC**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	146	147	157	155	167	285	298	304	253	200	164	147
10%	310	261	301	340	398	454	581	634	525	299	243	218
20%	419	394	352	444	508	514	646	743	706	597	528	454
30%	471	478	466	521	569	614	684	822	777	669	598	536
40%	557	516	555	580	599	634	704	846	867	724	628	571
50%	591	584	572	595	614	648	724	880	909	782	680	653
60%	617	597	600	603	620	660	776	905	931	825	694	670
70%	628	613	621	612	627	708	819	920	950	852	786	686
80%	664	630	629	623	651	748	844	944	972	871	810	742
90%	686	639	641	637	683	795	901	983	989	935	868	773
100%	734	675	683	723	725	851	959	998	1,013	971	972	814

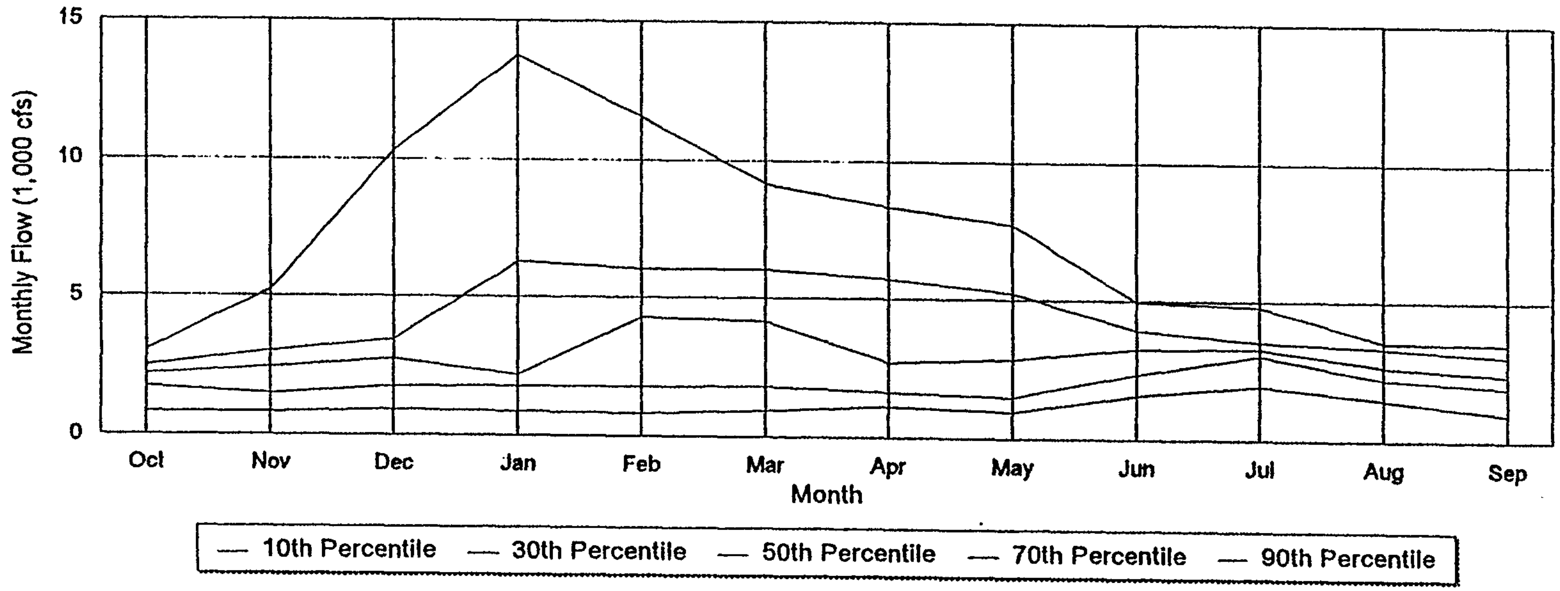
C-003277

C-003277

Figure 46. Historic American River Monthly Diversions
(No Data Available)

C-003278

Figure 47 Distribution of Historic Monthly Flow in the American River at Fair Oaks for Water Years 1962-1992



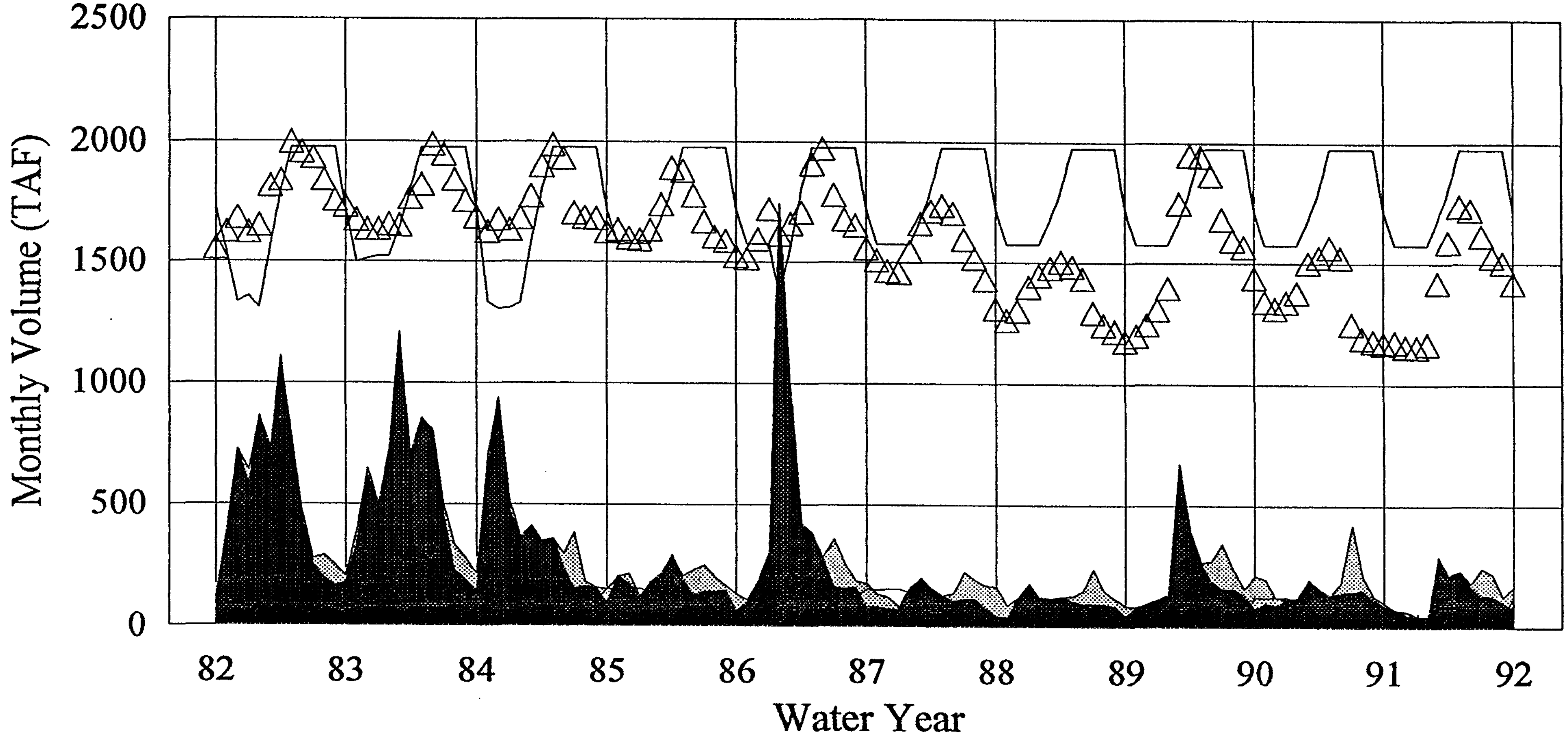
Historic Monthly Flow in the American River at Fair Oaks (cfs) for the 1962-1992 Period of Record
Average Flow = 3,710 cfs **Drainage Area = 1,888 sq. mi.** **Data Source: USGS**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	284	272	252	350	408	273	258	520	1,135	869	855	602	563
10%	810	817	886	850	816	931	1,110	953	1,579	1,921	1,457	954	1,202
20%	1,242	1,163	1,479	1,105	1,180	1,479	1,242	1,198	1,929	2,574	2,016	1,459	1,380
30%	1,713	1,472	1,728	1,756	1,753	1,777	1,608	1,485	2,343	3,002	2,206	1,890	1,693
40%	1,908	1,912	2,367	2,010	3,555	3,205	1,880	2,288	2,854	3,135	2,426	2,030	2,002
50%	2,157	2,426	2,720	2,166	4,258	4,154	2,696	2,832	3,235	3,261	2,650	2,356	2,152
60%	2,321	2,642	2,909	3,045	5,006	4,979	4,212	3,769	3,554	3,467	2,999	2,798	2,905
70%	2,470	2,989	3,420	6,280	6,036	6,045	5,754	5,238	3,913	3,512	3,315	3,015	3,613
80%	2,895	3,288	5,356	10,213	7,880	7,499	6,013	6,688	4,175	4,549	3,459	3,074	4,072
90%	3,014	5,223	10,290	13,787	11,574	9,155	8,337	7,742	4,961	4,820	3,530	3,464	4,357
100%	4,102	11,699	19,357	19,188	31,136	19,340	17,757	12,310	9,828	7,055	4,500	3,924	6,410

Figure 48

American River Flow Allocation

Historical



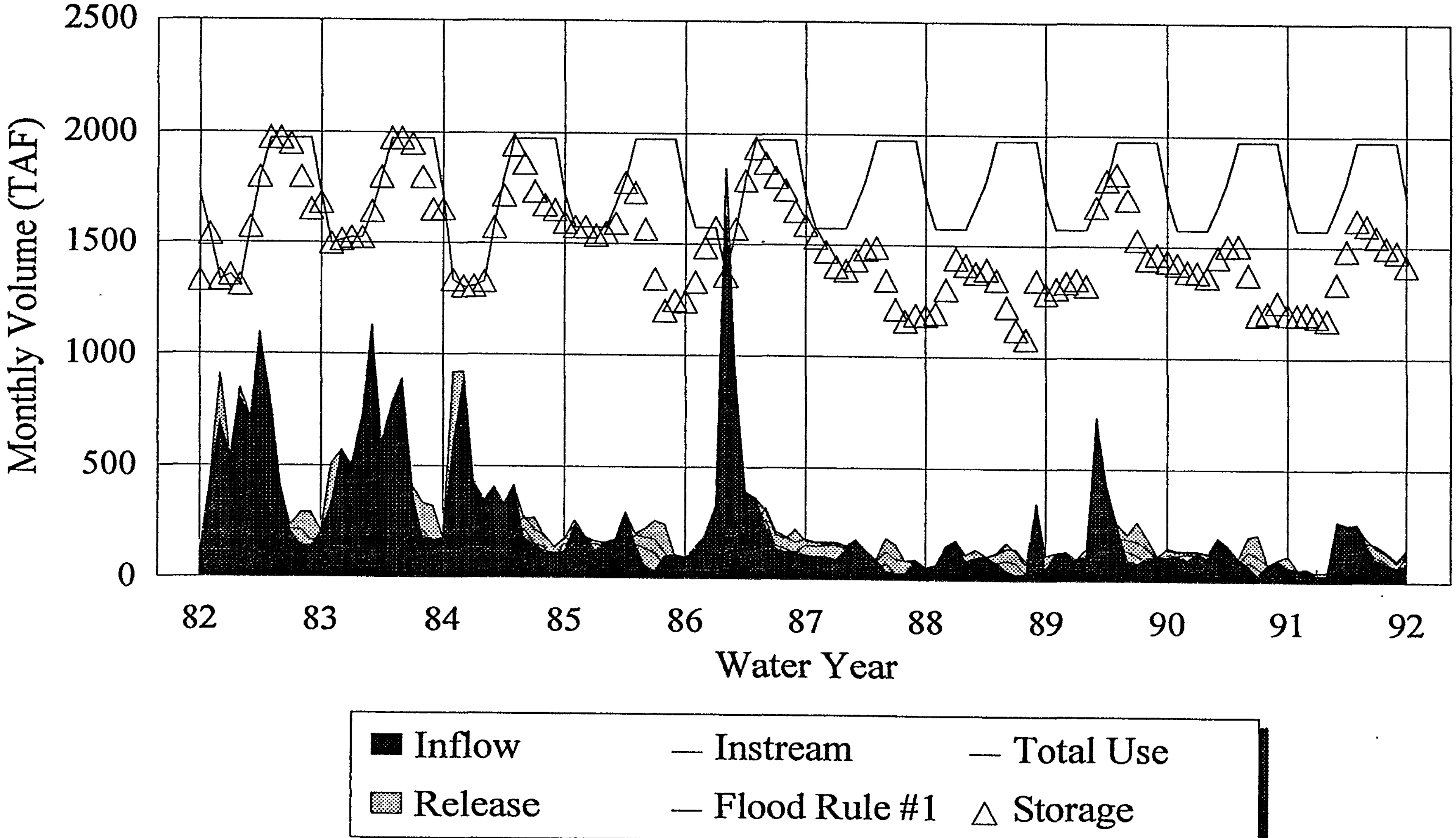
C-003280

C—003280

Figure 49

American River Flow Allocation

DWRSIM 472 CALFED No-Action



C-003281

C-003281

Figure 50

American River Monthly Diversion Exceedence

DWRSIM 472 CALFED No-Action

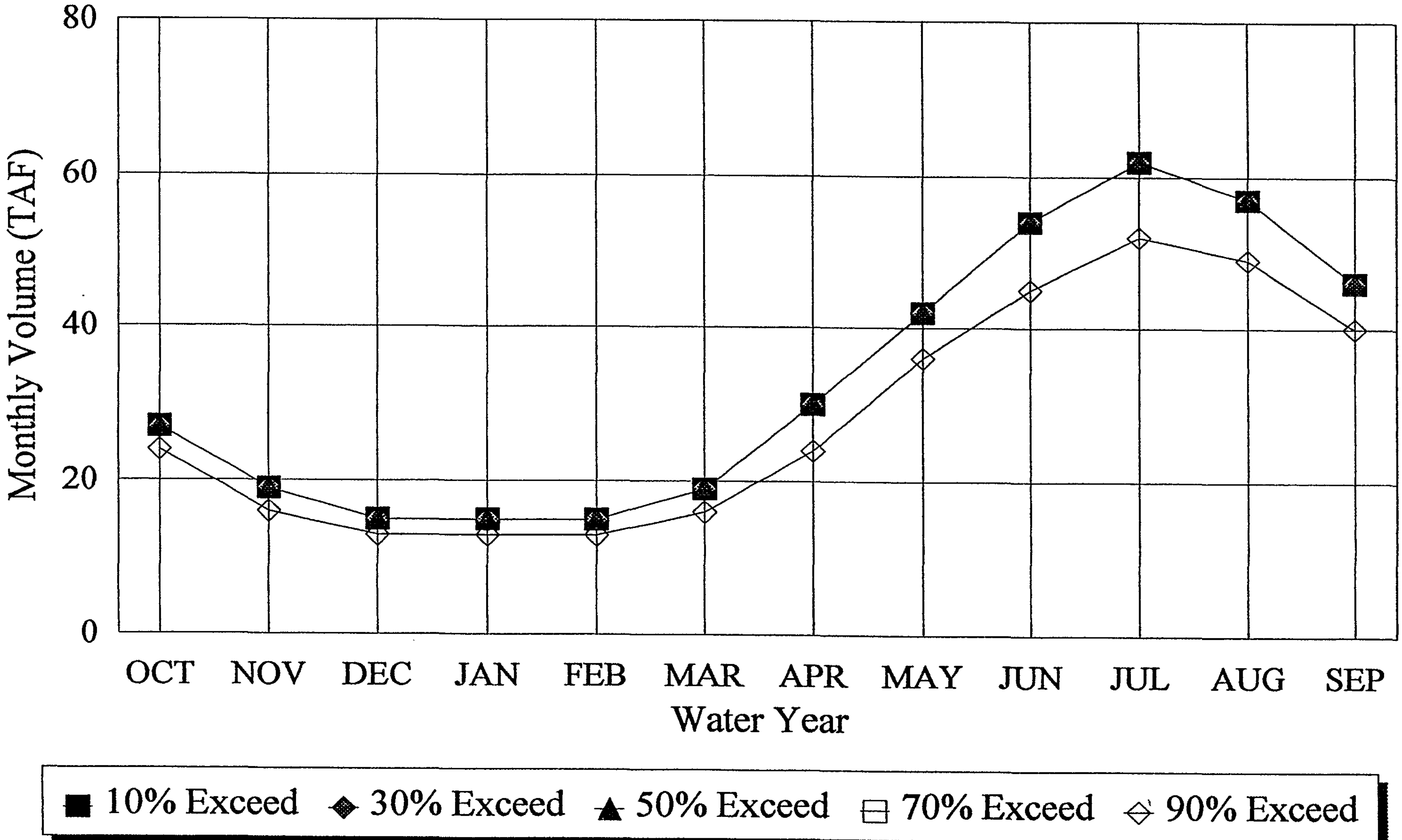
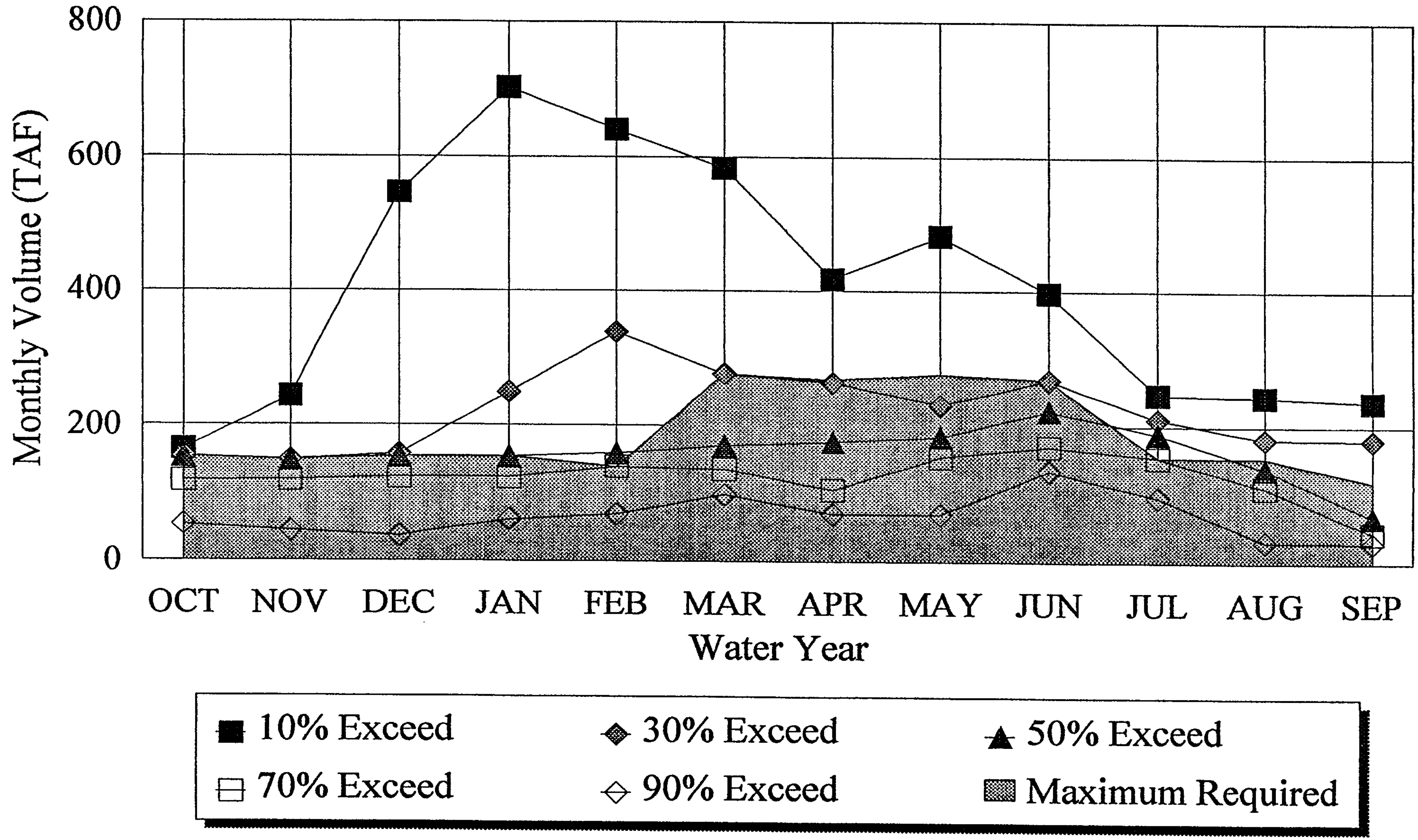


Figure 51

American River Monthly Flow Exceedence

DWRSIM 472 CALFED No-Action



C-003283

C — 0 0 3 2 8 3

Figure 52

American River Annual Water Allocation

DWRSIM 472 CALFED No-Action

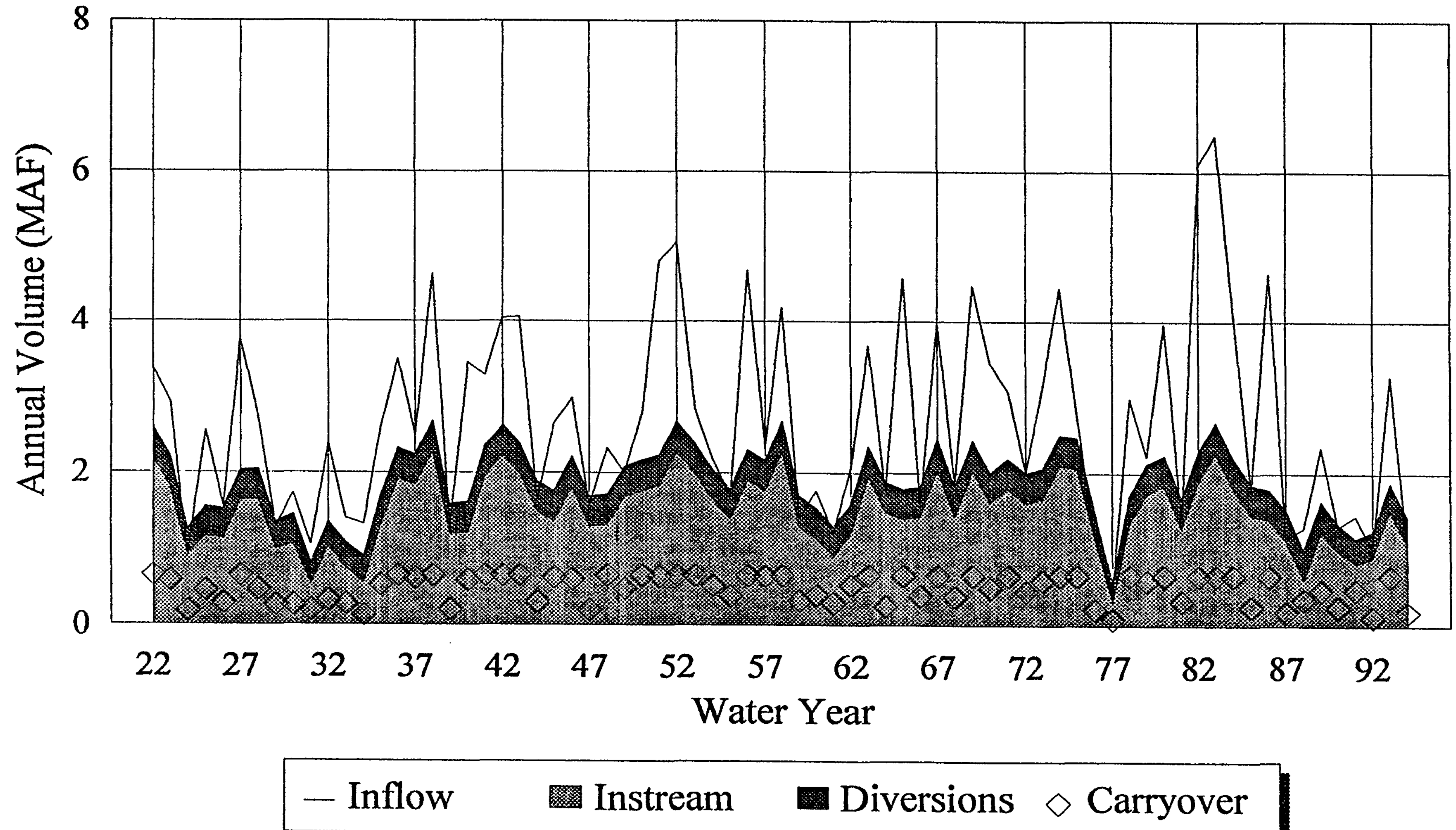
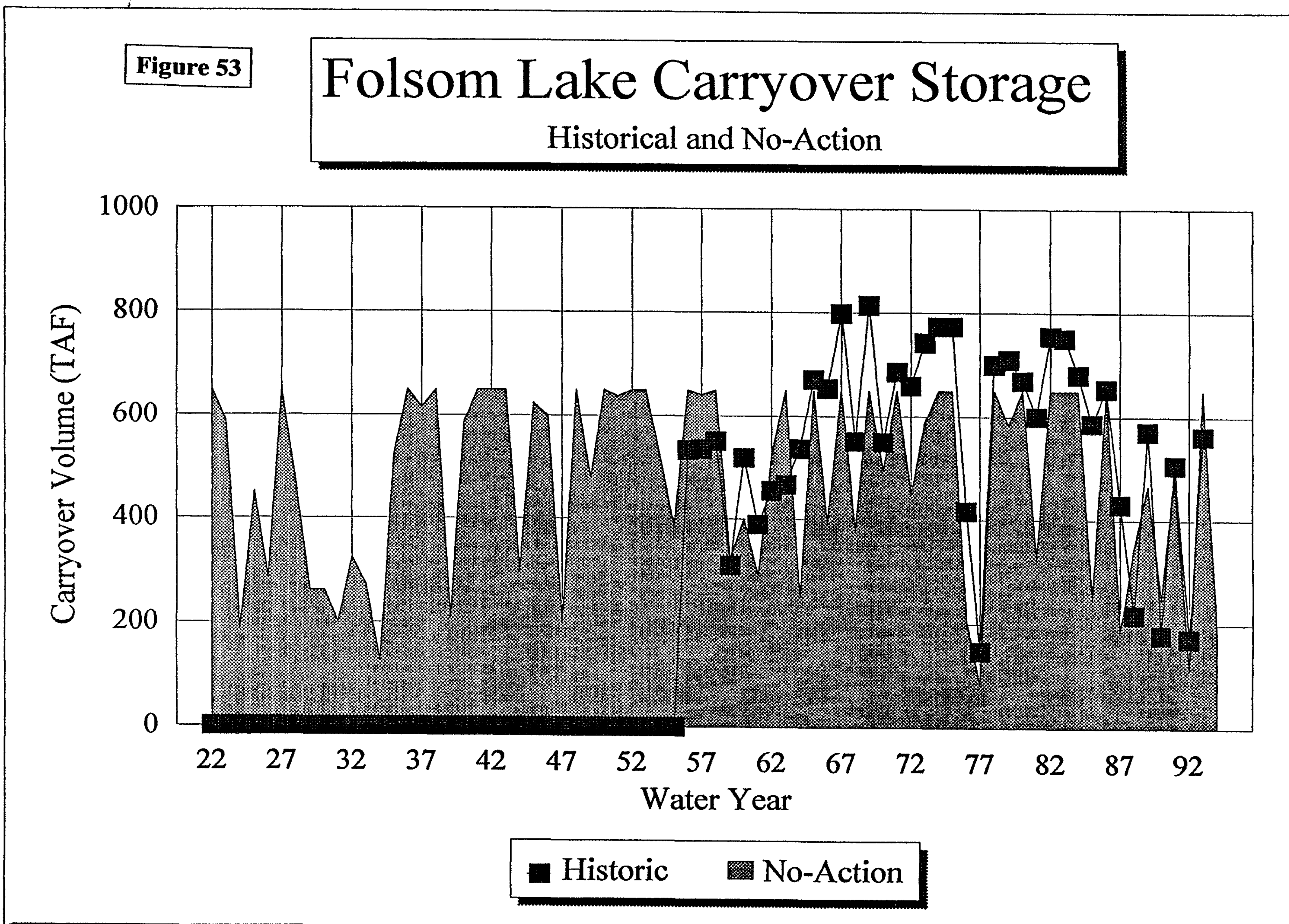


Figure 53

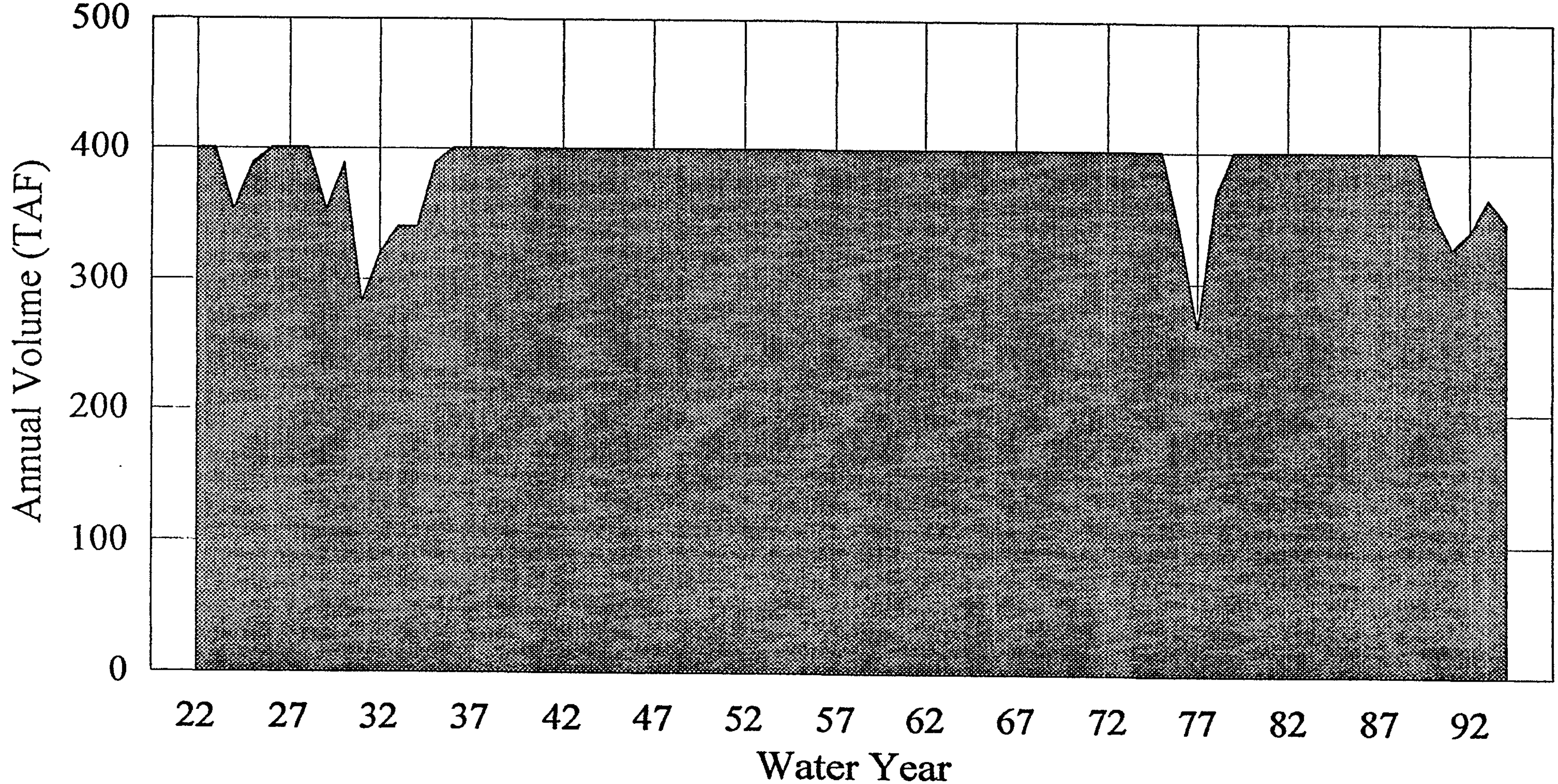


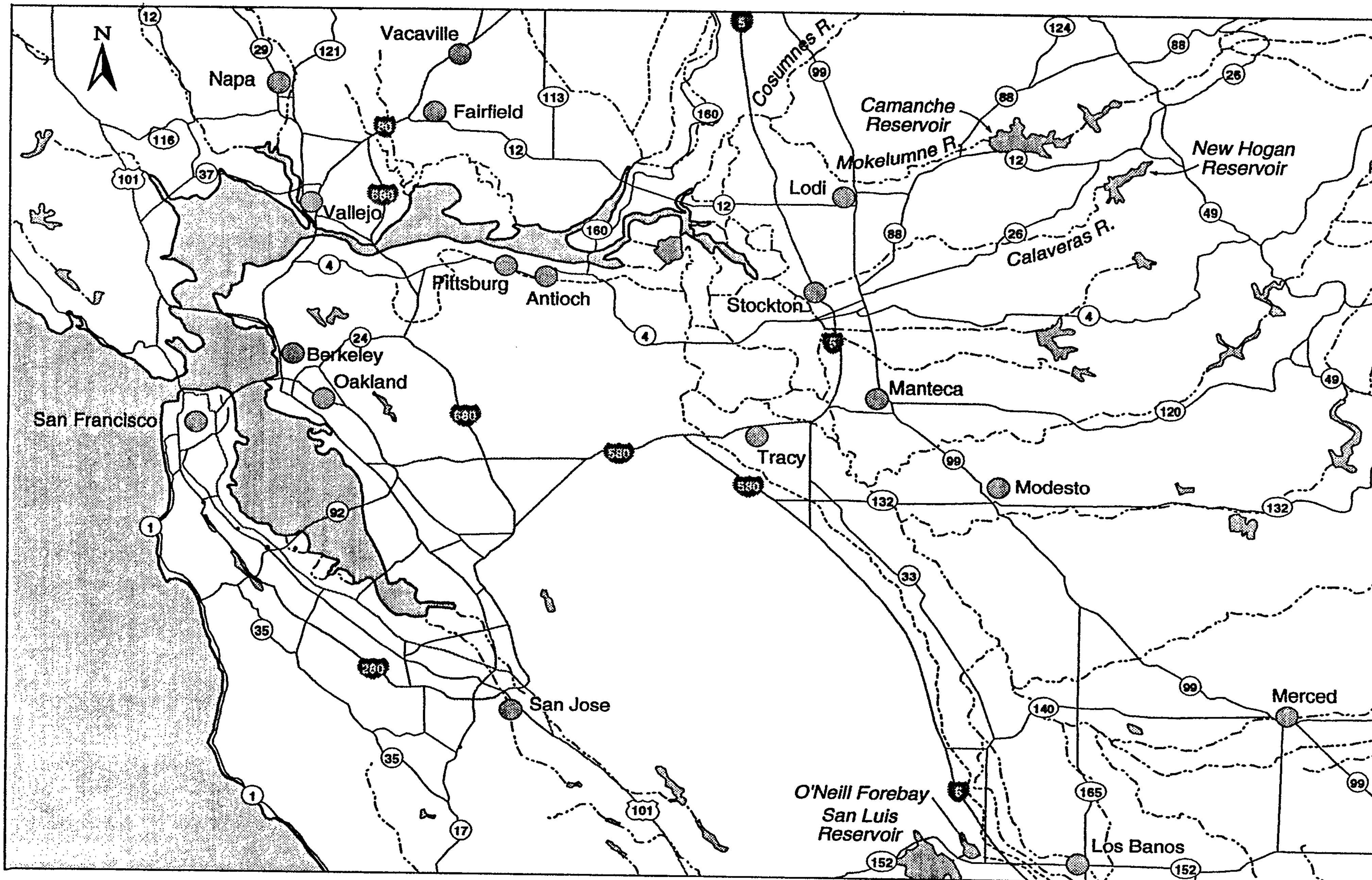
C-003285

Figure 54

American River Diversions

Historical (No Data) and No-Action



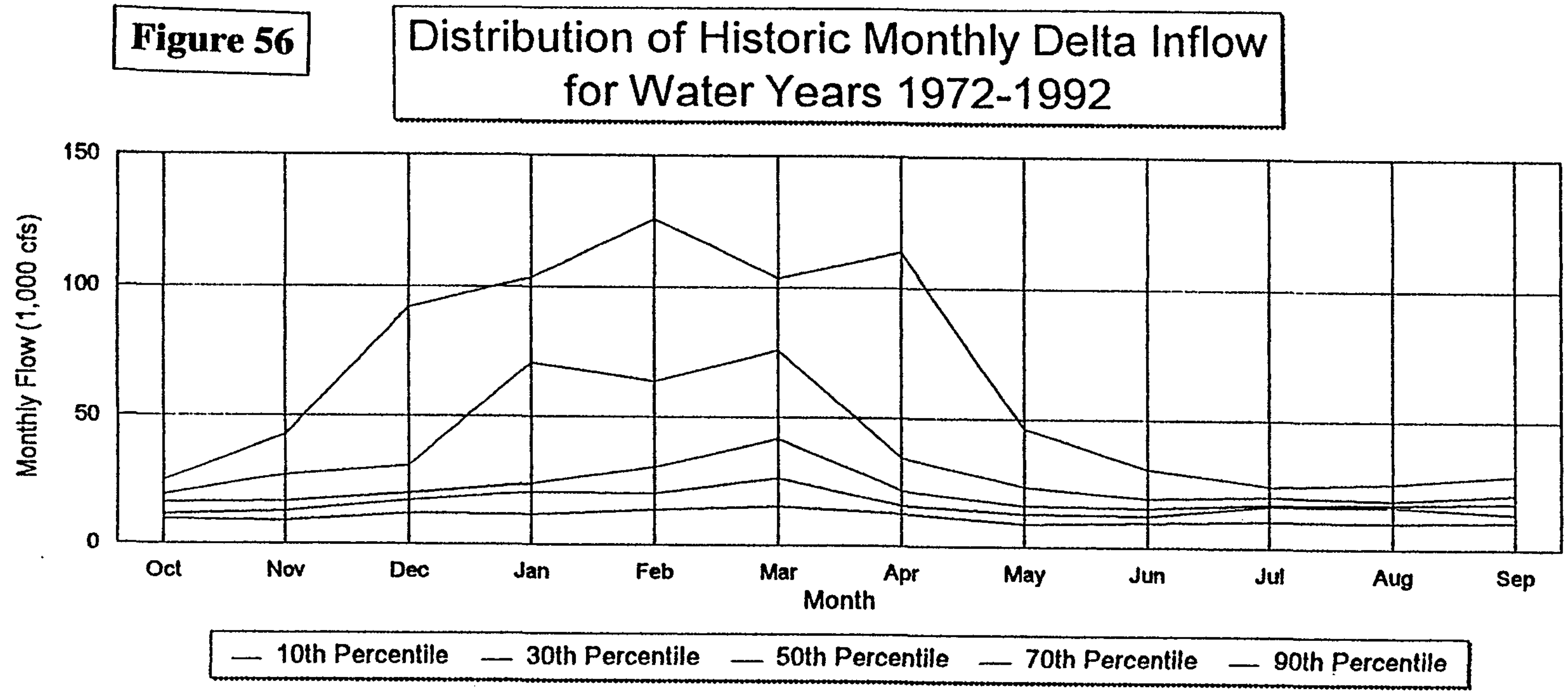


CALFED BAY-DELTA PROGRAM

Figure 55
Delta Water Management Facilities

C-003288

Figure 56



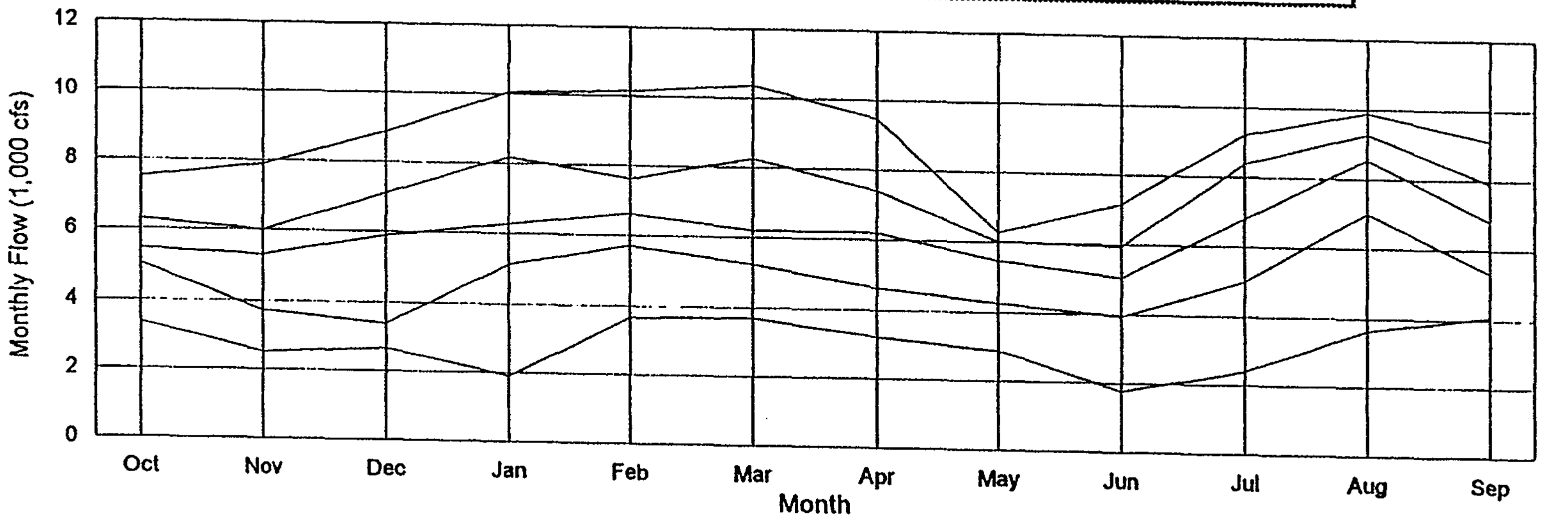
Historic Total Delta Inflow (cfs) for the 1972-1992 Period of Record
Average Flow = 31,948 cfs **Source: DWR**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	4,749	7,151	8,767	9,894	8,833	7,150	6,199	7,609	7,007	8,409	7,828	7,030	5,956
10%	9,405	9,059	11,826	11,640	13,511	15,136	12,602	8,895	9,810	10,332	10,253	10,751	9,046
20%	10,519	9,815	13,886	15,985	15,081	18,008	14,889	12,000	11,901	14,712	15,052	13,141	11,111
30%	11,441	12,739	16,945	20,356	20,150	26,036	15,831	12,991	12,426	16,238	16,222	13,938	12,744
40%	15,802	16,284	17,406	23,286	25,859	29,233	19,370	16,028	14,573	16,644	16,328	14,352	13,665
50%	16,035	16,503	19,917	23,540	30,486	41,627	21,618	16,138	15,291	17,133	17,250	17,981	14,970
60%	18,057	18,181	25,150	28,789	46,831	47,293	23,898	20,603	17,950	18,751	17,623	19,346	24,747
70%	19,310	26,812	30,721	70,897	63,704	75,981	34,672	23,530	19,144	20,306	18,871	21,367	28,260
80%	20,058	31,819	39,733	98,112	100,549	86,350	50,073	35,108	24,577	21,852	21,565	23,021	35,353
90%	24,647	42,769	91,853	103,431	125,777	103,281	113,459	46,246	30,754	24,061	25,319	28,668	42,559
100%	36,150	71,675	155,567	139,274	207,820	266,621	149,356	103,031	79,795	53,418	35,542	37,543	68,742

C-003288

Figure 57

Distribution of Total CVP and SWP Monthly Exports for Water Years 1972-1992



— 10th Percentile — 30th Percentile — 50th Percentile — 70th Percentile — 90th Percentile

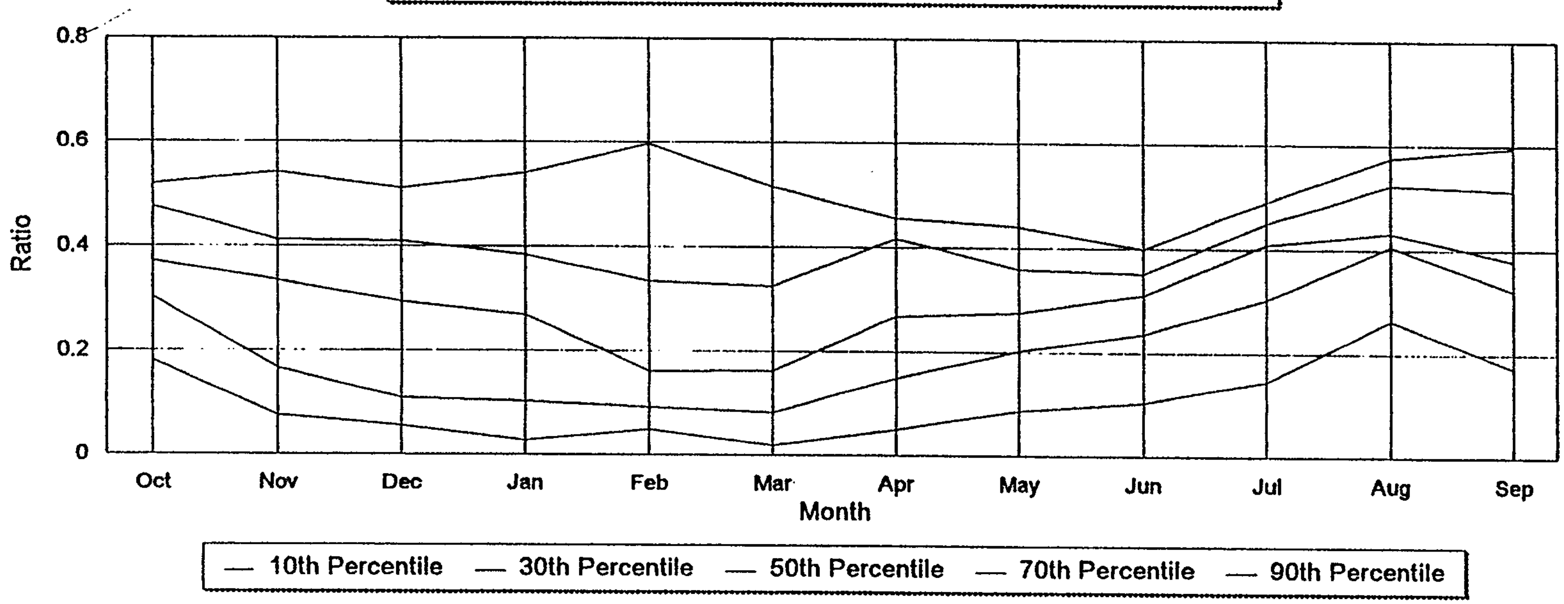
Total CVP and SWP Monthly Exports (cfs) for the 1972-1992 Period of Record
Average Flow = 6,057 cfs
Data Source: DWR

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	628	1,686	2,088	1,549	1,114	1,216	1,176	1,536	557	701	1,388	1,734	2,077
10%	3,364	2,527	2,659	1,917	3,661	3,688	3,209	2,877	1,770	2,401	3,650	4,074	3,186
20%	4,471	3,045	3,045	4,038	4,384	4,286	3,755	3,175	3,765	3,876	6,624	4,940	3,434
30%	5,023	3,708	3,384	5,127	5,700	5,221	4,612	4,267	3,930	5,010	7,016	5,312	3,898
40%	5,202	4,632	5,127	5,756	6,002	5,883	5,269	5,075	4,841	6,007	7,913	5,692	4,365
50%	5,456	5,307	5,894	6,284	6,634	6,209	6,196	5,471	5,044	6,808	8,539	6,817	4,484
60%	5,787	5,745	6,687	6,927	7,162	6,856	6,837	5,859	5,691	7,720	9,015	7,502	4,606
70%	6,300	6,004	7,112	8,178	7,628	8,256	7,399	6,014	5,950	8,378	9,265	7,897	4,819
80%	7,432	6,712	8,367	9,794	9,402	9,652	7,983	6,080	6,143	9,116	9,560	8,545	5,294
90%	7,518	7,893	8,861	10,057	10,155	10,362	9,465	6,282	7,161	9,209	9,884	9,090	5,582
100%	10,351	10,224	10,297	10,484	10,405	10,405	10,302	7,015	8,942	10,493	11,057	10,534	5,968

C-003290

Figure 58

Distribution of the Ratio of Delta Exports to Delta Inflow for Water Years 1972-1992



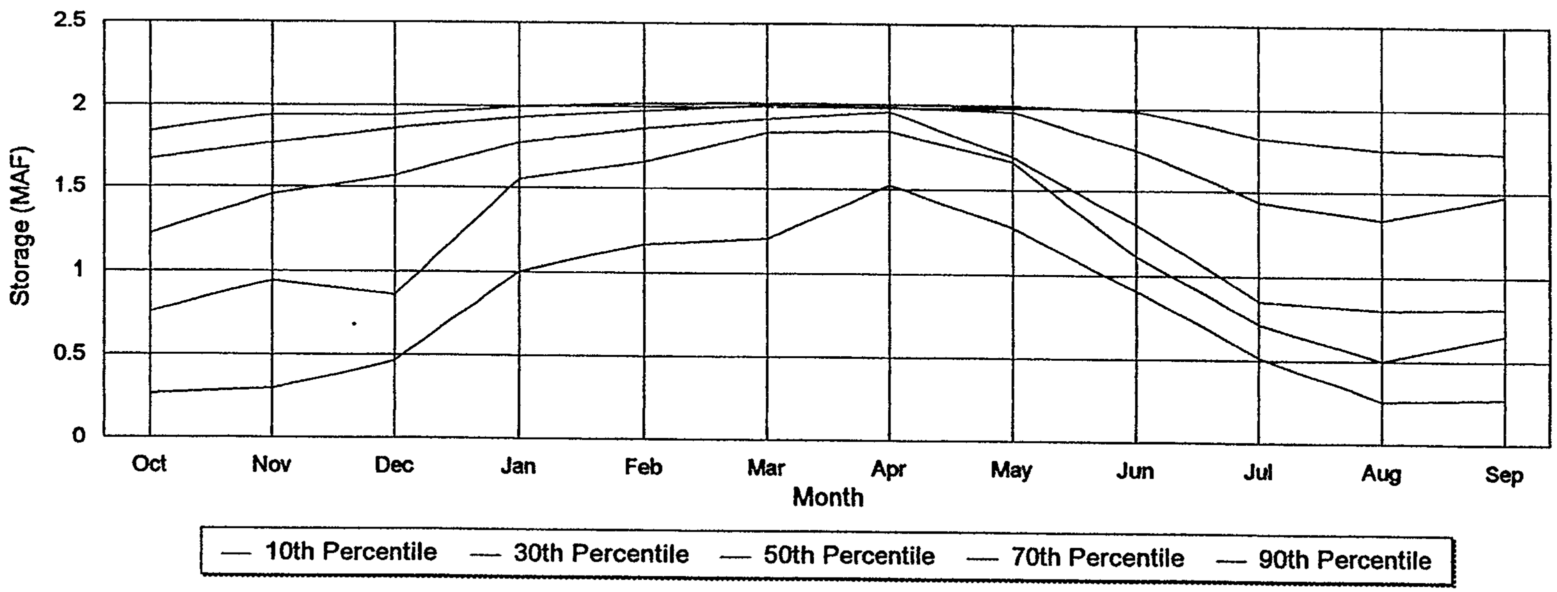
Ratio of Delta Exports (CVP+SWP) to Delta Inflow for the 1972-1992 Period of Record
Average Ratio = 0.31 **Data Source: DWR**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Average
0%	0.07	0.02	0.01	0.01	0.01	0.02	0.03	0.03	0.06	0.08	0.18	0.11	0.05
10%	0.18	0.08	0.06	0.03	0.05	0.02	0.05	0.09	0.10	0.15	0.26	0.17	0.10
20%	0.19	0.13	0.09	0.05	0.06	0.07	0.09	0.16	0.18	0.23	0.36	0.25	0.16
30%	0.30	0.17	0.11	0.10	0.09	0.08	0.15	0.20	0.24	0.30	0.41	0.32	0.21
40%	0.30	0.29	0.24	0.14	0.12	0.12	0.19	0.26	0.30	0.31	0.43	0.37	0.26
50%	0.37	0.33	0.29	0.27	0.16	0.16	0.27	0.28	0.31	0.41	0.43	0.38	0.31
60%	0.41	0.36	0.34	0.36	0.25	0.21	0.34	0.29	0.33	0.41	0.46	0.45	0.35
70%	0.48	0.41	0.41	0.38	0.33	0.33	0.42	0.36	0.35	0.45	0.52	0.51	0.41
80%	0.51	0.45	0.46	0.48	0.49	0.47	0.43	0.37	0.39	0.48	0.56	0.58	0.47
90%	0.52	0.54	0.51	0.54	0.60	0.52	0.45	0.44	0.40	0.49	0.58	0.60	0.51
100%	0.66	0.62	0.61	0.71	0.72	0.69	0.59	0.47	0.45	0.51	0.61	0.66	0.61

C-003290

Figure 59

Distribution of End-of-Month Storage in San Luis Reservoir for Water Years 1971-1991

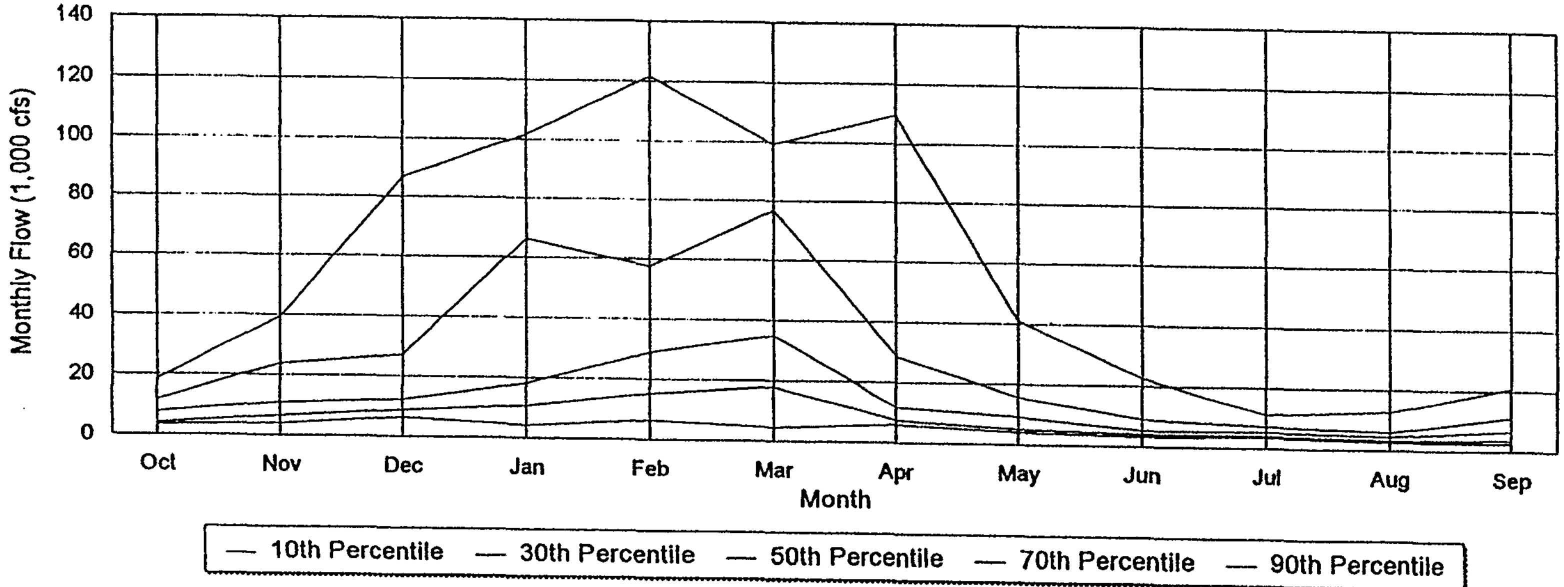


Historic End-of-Month Storage in San Luis Reservoir (TAF) for the 1971-1991 Period of Record
Average Storage = 1,393 TAF
Data Source: CDEC

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	54	191	79	81	250	642	1065	1065	671	268	63	23
10%	261	293	464	1002	1166	1204	1530	1276	905	514	259	274
20%	517	658	563	1109	1546	1781	1791	1540	1078	690	423	488
30%	754	940	854	1555	1660	1844	1860	1672	1112	710	500	654
40%	922	1165	1268	1610	1775	1879	1966	1686	1229	726	569	688
50%	1219	1454	1572	1778	1865	1923	1973	1704	1299	853	800	812
60%	1617	1738	1723	1885	1937	1954	1995	1912	1545	1244	1069	1213
70%	1670	1768	1859	1928	1974	2011	2003	1977	1750	1442	1334	1482
80%	1752	1852	1926	1988	1998	2022	2016	1984	1902	1709	1542	1691
90%	1840	1941	1938	1996	2019	2025	2019	2018	1988	1833	1756	1736
100%	1998	1975	1984	2019	2022	2027	2028	2027	2018	1932	1857	1940

Figure 60

Distribution of Historic Delta Monthly Outflow for Water Years 1972-1992



Historic Delta Monthly Outflow (cfs) for the 1972-1992 Period of Record
Average Flow = 24,696 cfs

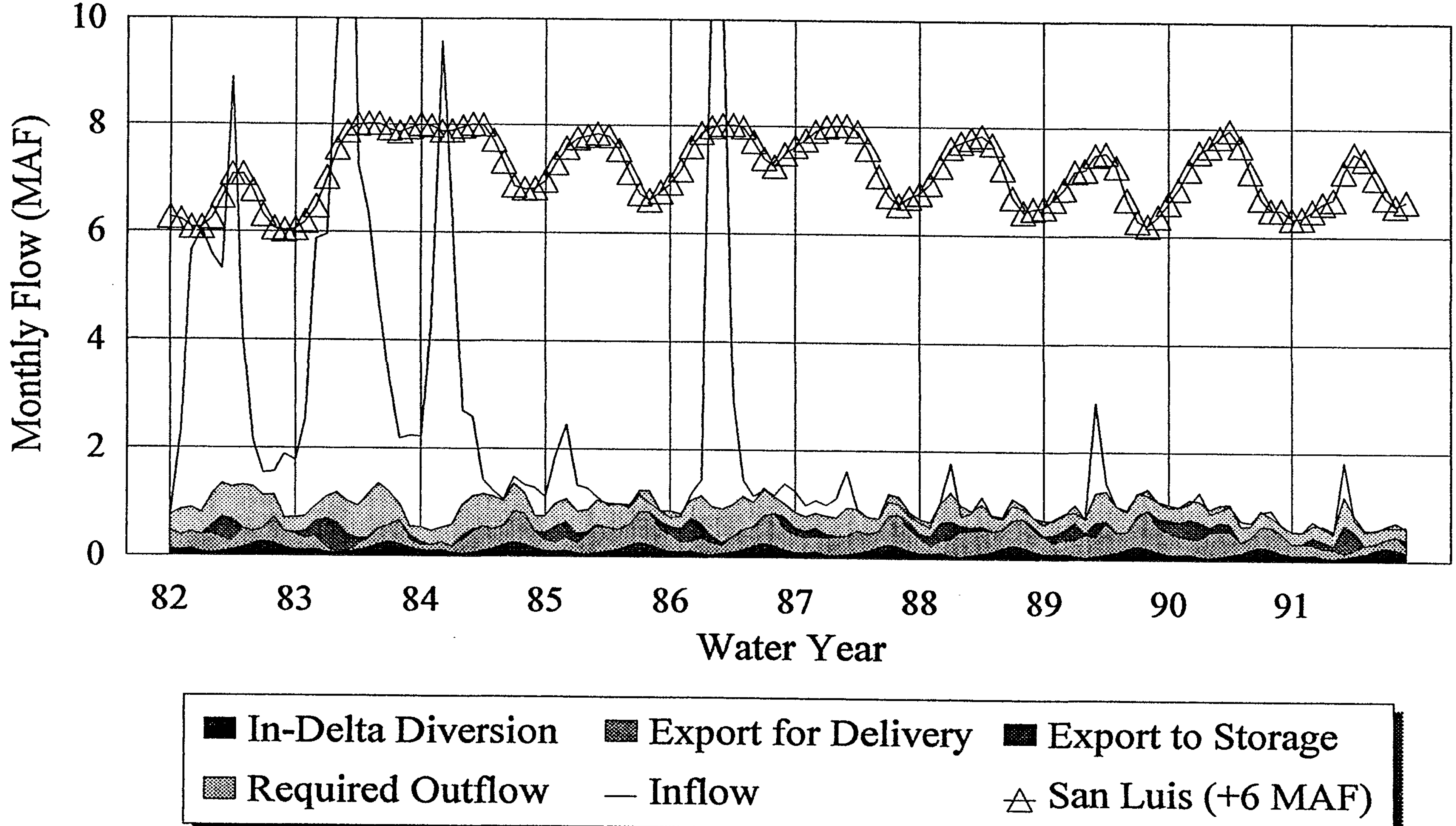
Data Source: DWR

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	2,075	3,644	4,213	3,635	3,045	3,070	3,083	3,454	2,521	3,140	2,325	1,790	2,527
10%	3,378	4,004	6,425	4,365	6,405	4,542	6,041	3,999	3,197	3,479	2,514	2,594	4,384
20%	3,623	4,558	7,661	9,346	7,420	10,432	6,374	4,748	3,627	3,920	2,851	3,211	5,158
30%	3,990	6,660	8,779	10,819	15,590	18,078	7,542	5,140	4,169	4,115	3,161	3,670	6,578
40%	5,218	6,891	9,431	15,209	21,174	24,626	11,499	7,531	4,999	4,599	4,253	4,690	7,876
50%	7,821	10,928	12,488	18,326	28,805	34,929	11,808	9,143	5,326	5,296	4,612	6,555	9,133
60%	10,628	13,743	19,953	21,339	46,341	38,951	14,732	11,699	7,211	6,211	5,135	10,476	19,891
70%	11,919	23,991	27,133	66,171	57,330	76,907	28,689	15,911	9,086	7,384	5,963	11,153	24,382
80%	14,071	25,953	31,067	97,706	92,770	80,089	46,572	25,544	14,870	10,252	8,272	13,419	29,675
90%	18,529	39,152	86,579	101,685	121,653	99,171	109,547	40,874	22,508	11,191	12,783	20,981	37,422
100%	32,293	74,138	155,458	138,699	205,414	266,688	142,203	98,707	71,038	43,860	24,567	31,501	64,296

Figure 61

Delta Inflow Allocation

Historical



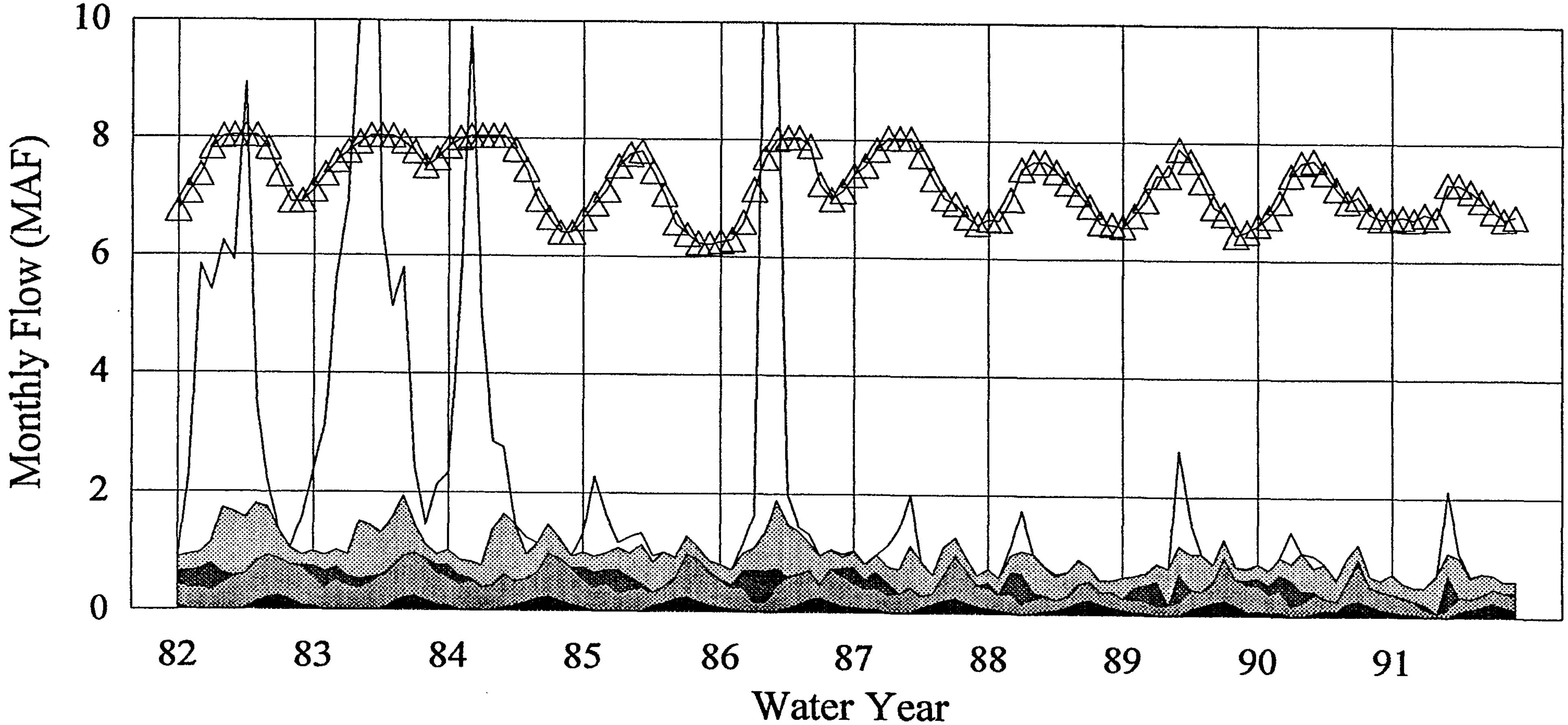
C-003293

C—003293

Figure 62

Delta Inflow Allocation

DWRSIM 472 CALFED No-Action



C-003294

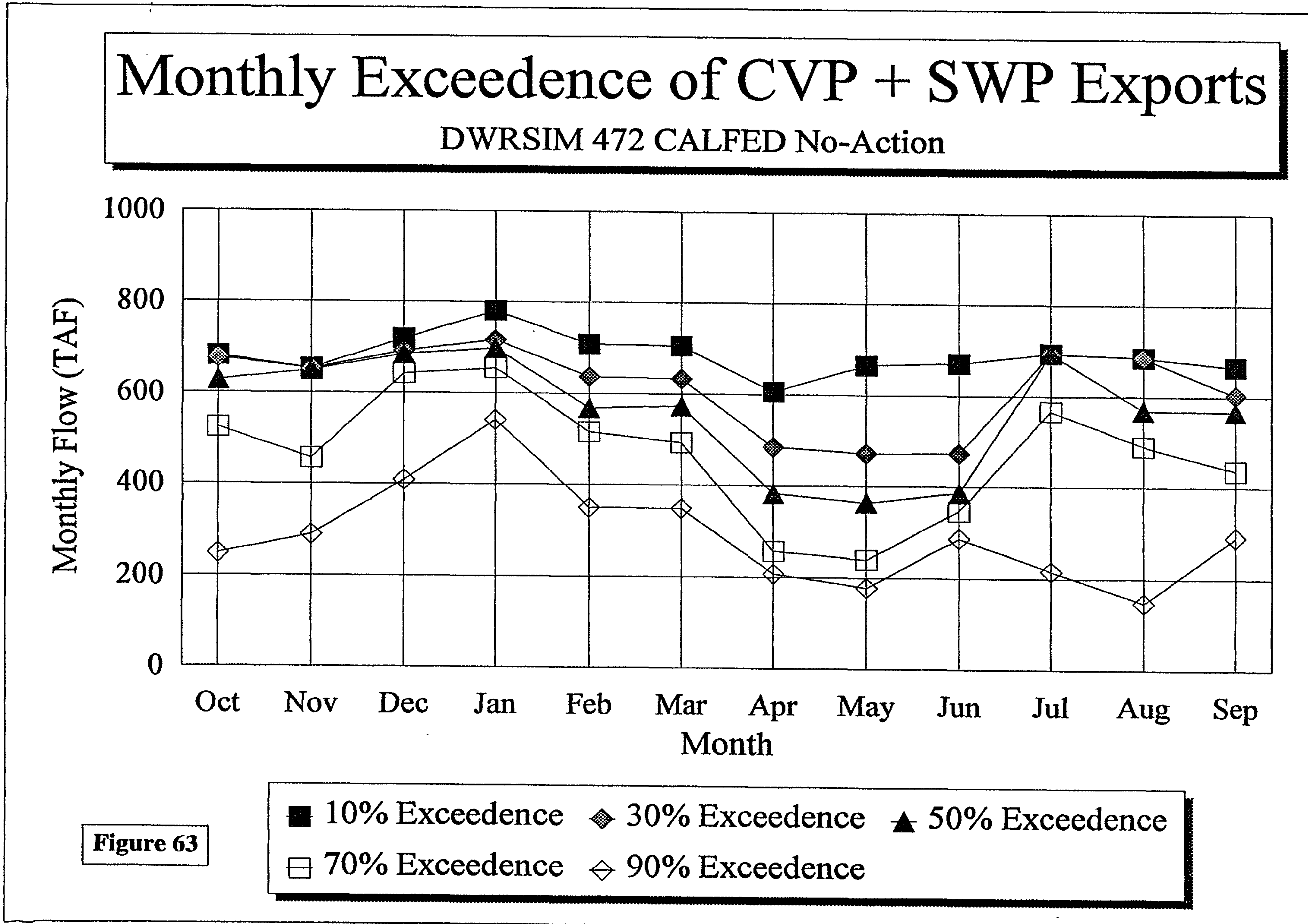
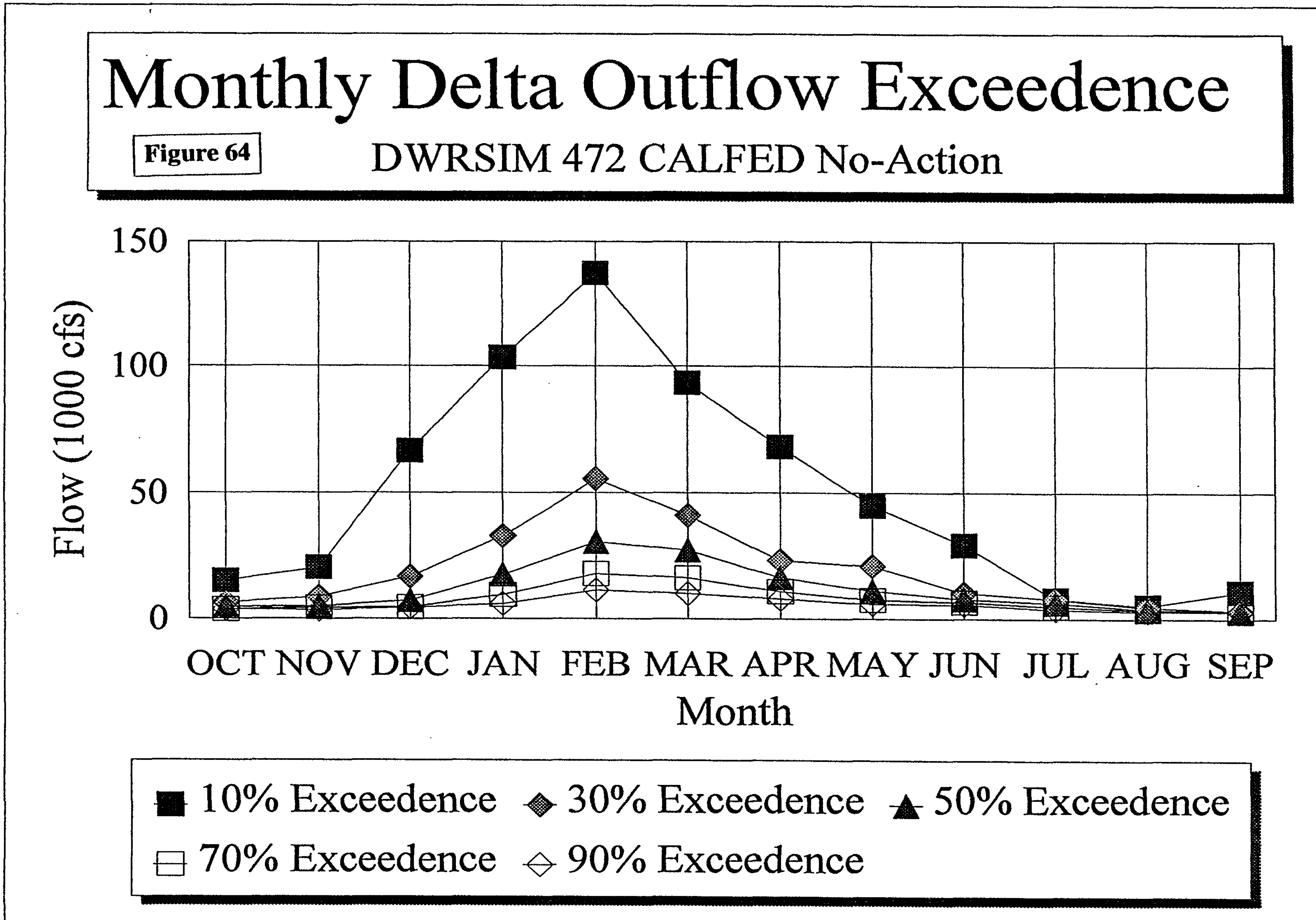


Figure 63

C-003295



C-003296

C-003296

Figure 65

Annual Delta Water Allocation

DWRSIM 472 CALFED No-Action

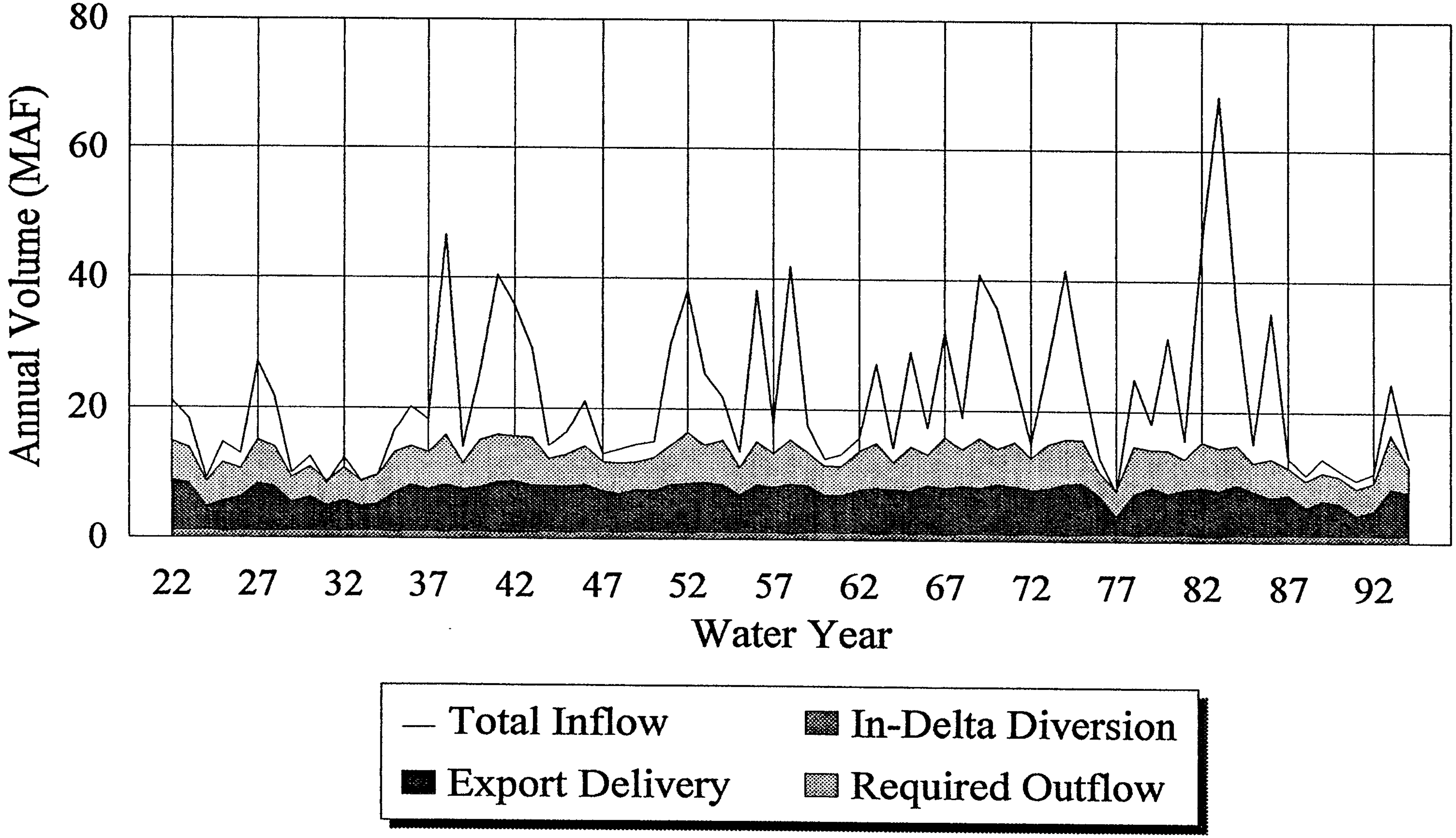


Figure 66

San Luis Reservoir Carryover Storage

Historical and No-Action

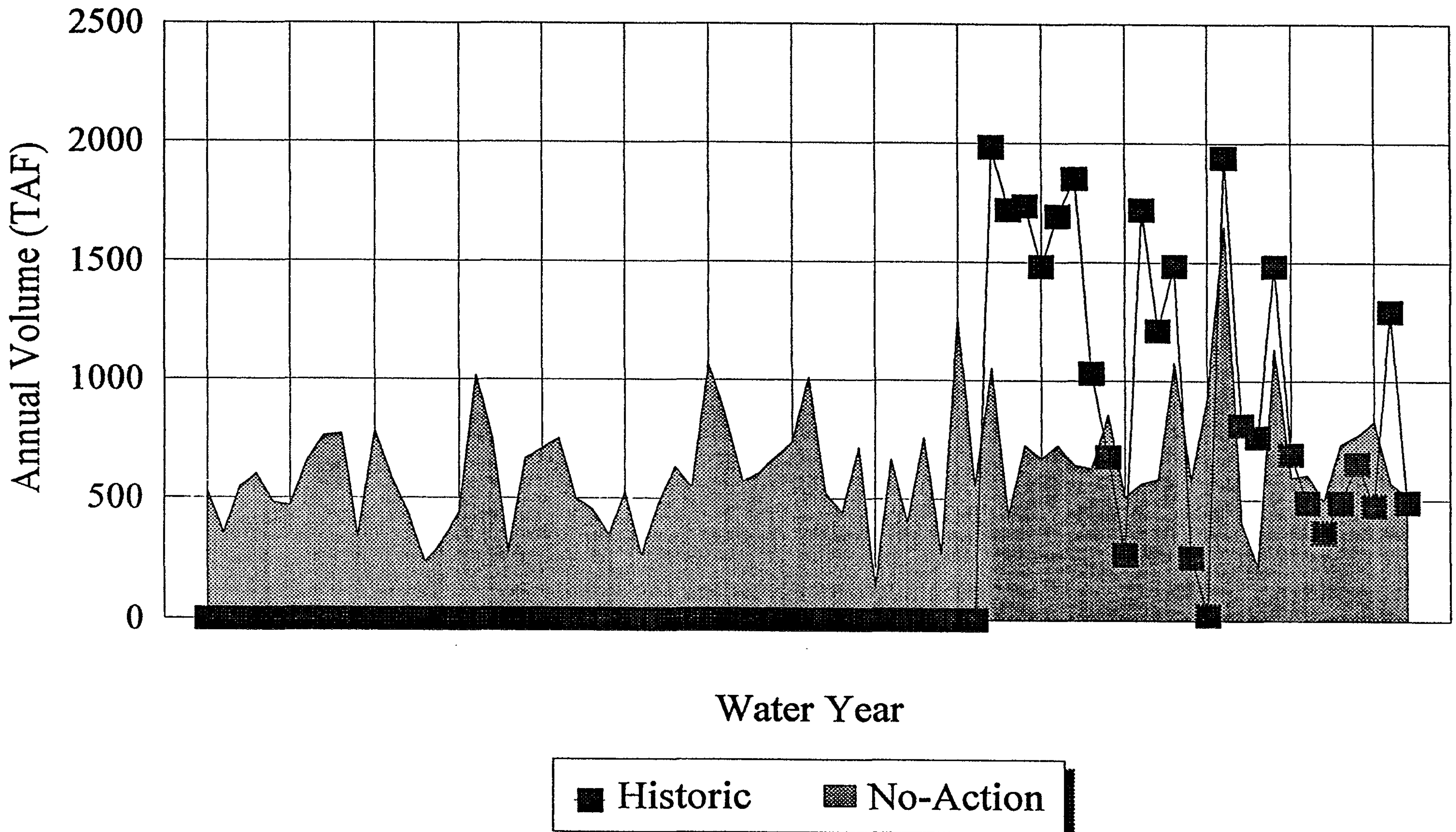
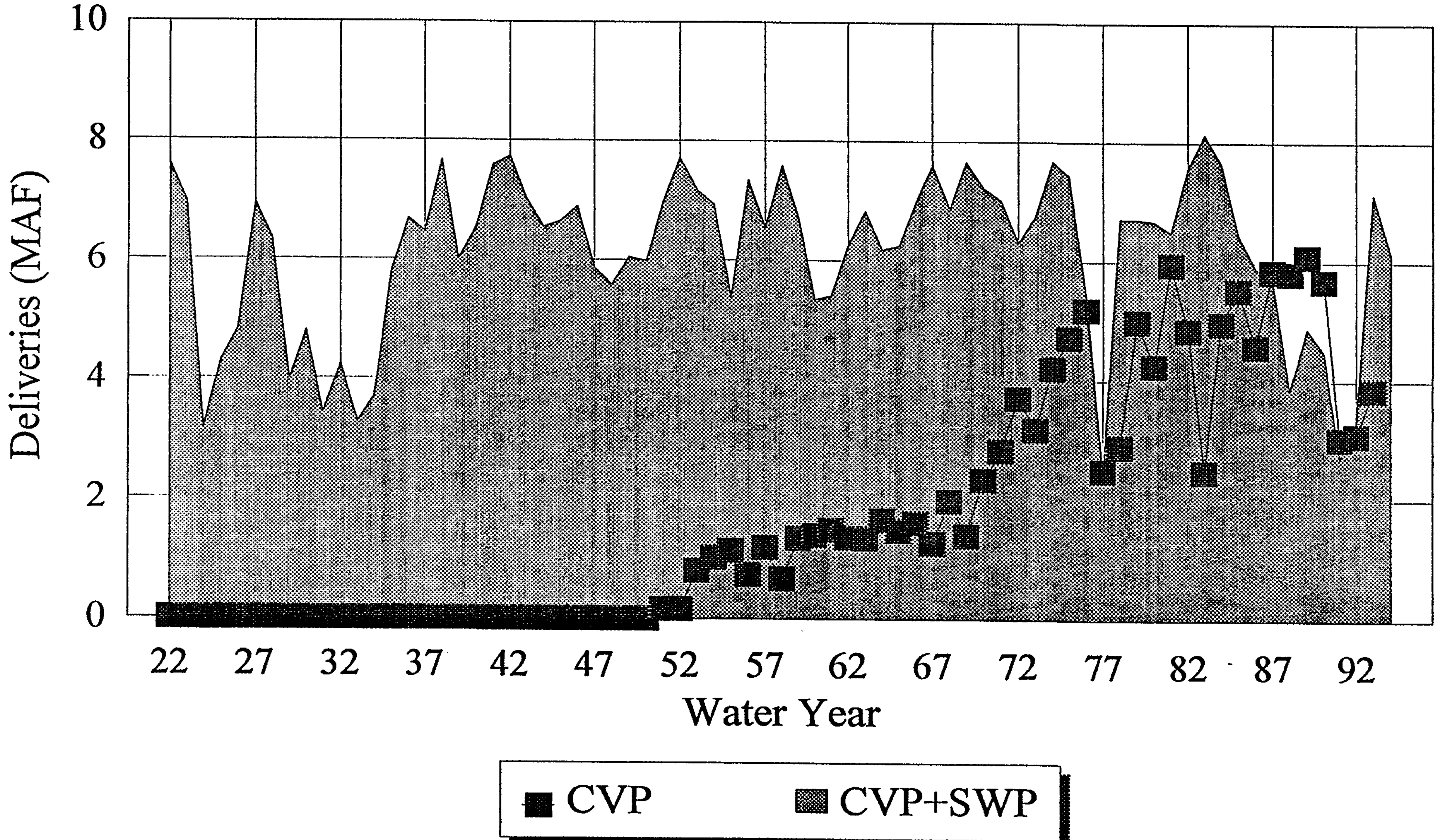


Figure 67

Annual CVP & SWP Aqueduct Deliveries

Historical and No-Action



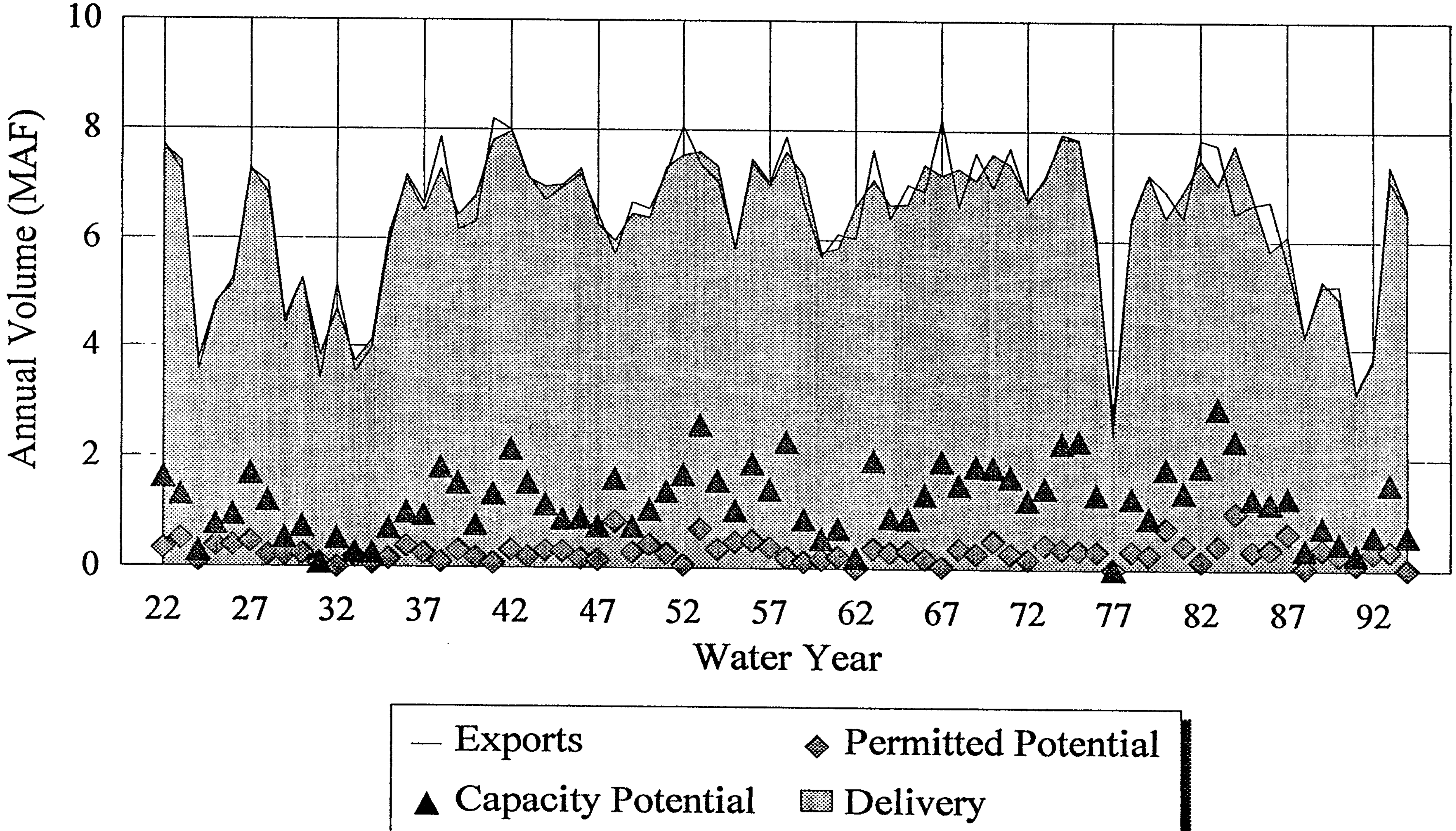
C-003299

C-003299

Figure 68

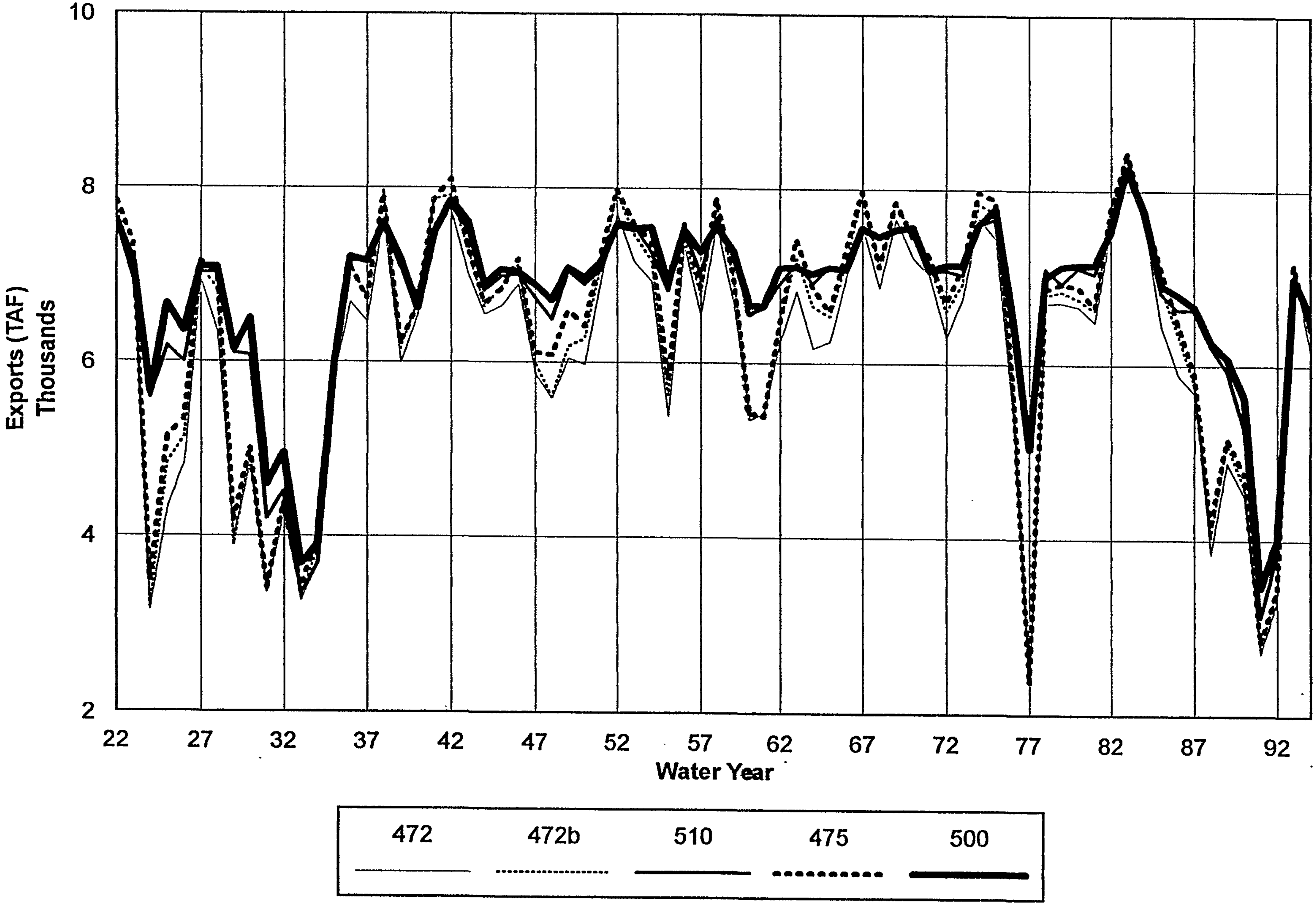
Annual Potential Delta Export

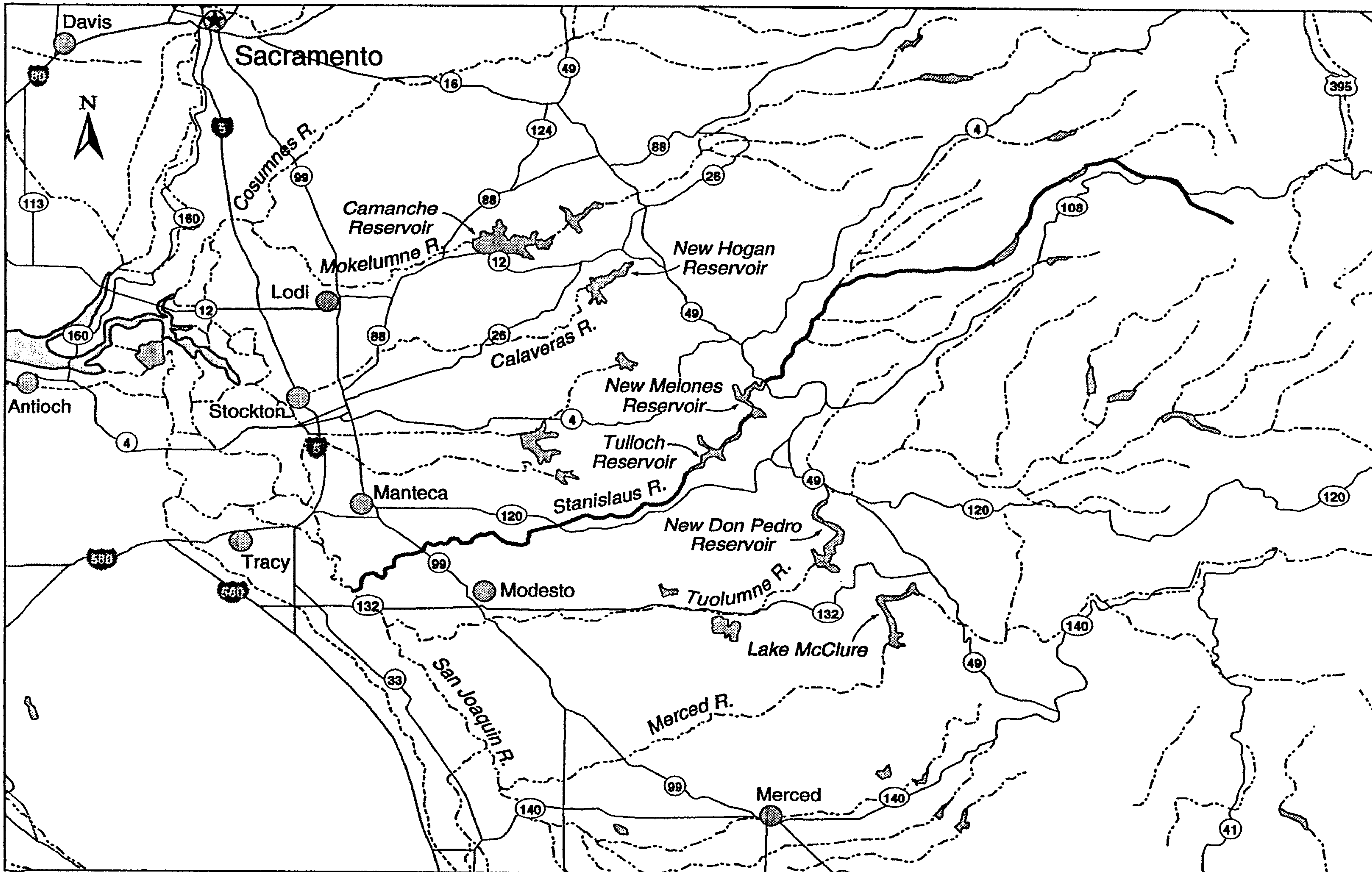
DWRSIM 472 CALFED No-Action



Del. pre

Figure 69 CVP + SWP Deliveries



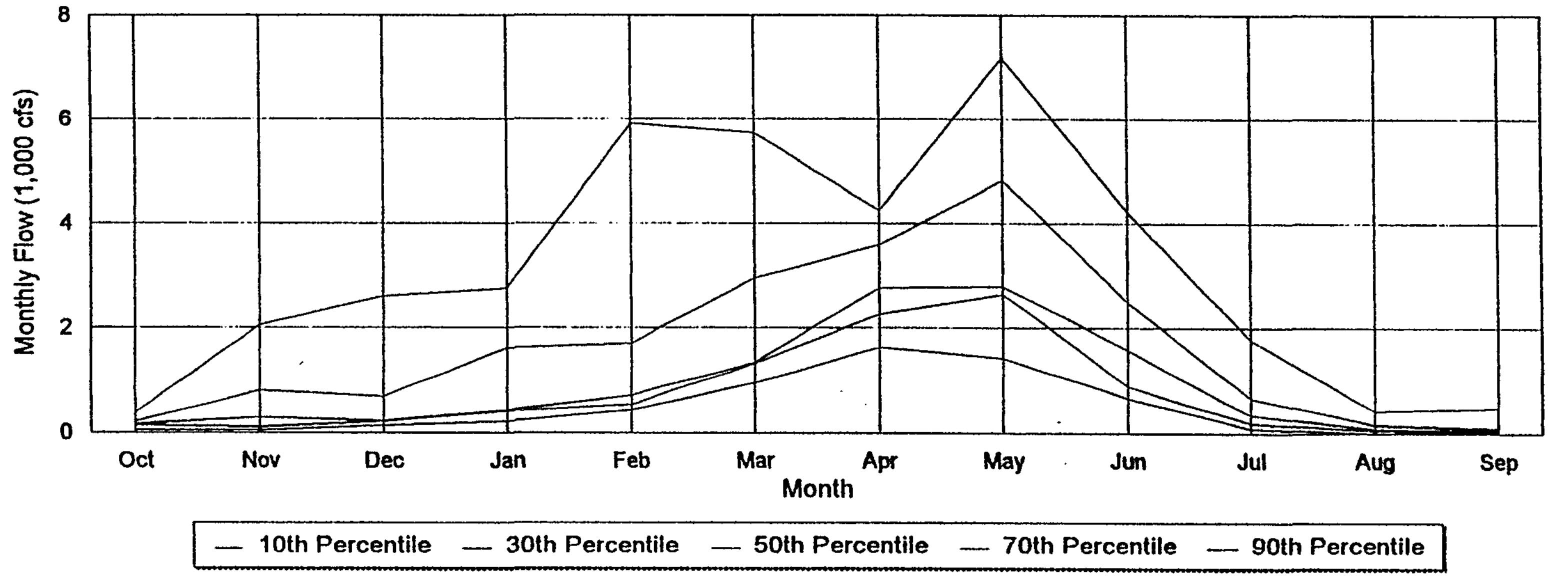


CALFED BAY-DELTA PROGRAM

Figure 70
Stanislaus River Basin Water Management Facilities

C-003303

Figure 71 Distribution of Unimpaired Monthly Flow in the Stanislaus River at Melones Reservoir for Water Years 1981-1991

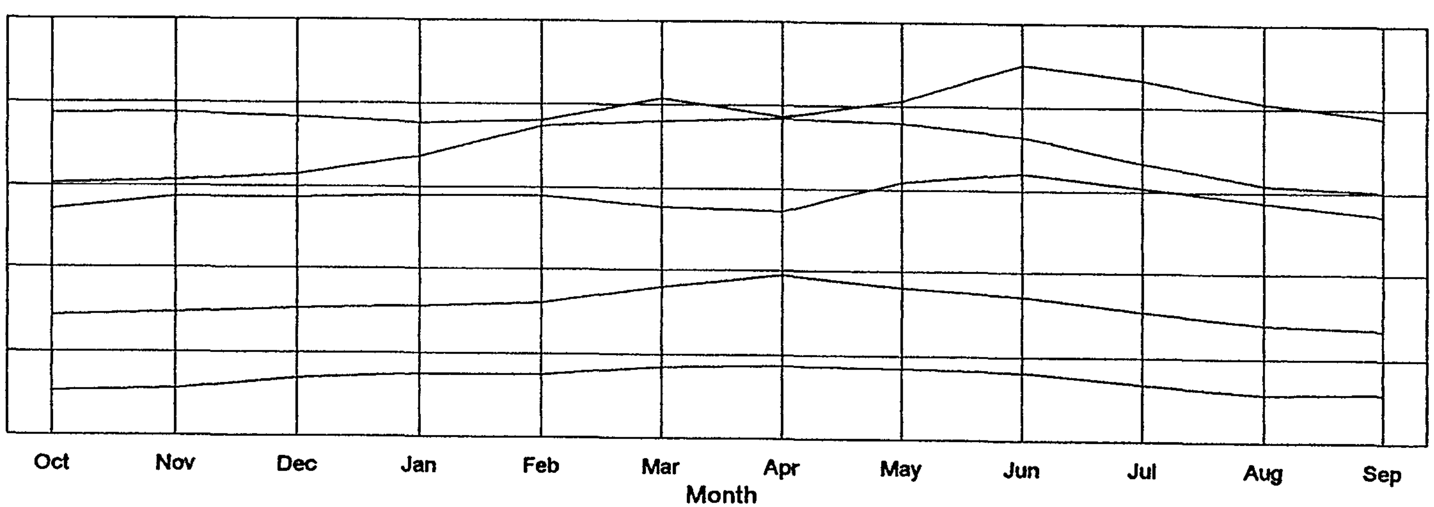


Unimpaired Monthly Flow in the Stanislaus River at Melones Reservoir (cfs) for the 1981-1991 Period of Record
Average Flow = 1,569 cfs **Drainage Area = 904 sq. mi.** **Data Source: DWR**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	0	34	49	49	18	960	1,445	1,350	454	49	0	0	372
10%	49	50	146	211	432	960	1,630	1,415	672	98	16	0	377
20%	49	101	195	293	522	1,285	1,748	1,529	857	179	49	17	469
30%	146	118	211	407	540	1,317	2,252	2,635	891	195	65	34	510
40%	146	168	228	423	608	1,334	2,638	2,683	958	195	98	50	590
50%	163	286	228	439	720	1,350	2,756	2,781	1,580	342	98	67	678
60%	179	672	504	651	864	2,228	3,462	2,976	1,781	390	114	84	780
70%	211	807	699	1,610	1,704	2,944	3,580	4,830	2,487	667	163	101	1,431
80%	358	1,681	2,488	2,342	4,411	4,115	3,933	4,879	3,613	927	309	420	1,936
90%	390	2,050	2,602	2,749	5,924	5,741	4,252	7,172	4,218	1,773	423	487	2,346
100%	1,431	3,781	3,041	2,976	9,579	6,684	7,277	8,197	10,621	4,651	1,252	639	2,950

C—003303

Figure 72 Distribution of End-of-Month Storage in New Melones Reservoir for Water Years 1981-1991



Historic End-of-Month Storage in New Melones Reservoir (TAF) for the 1981-1991 Period of Record
Average Storage = 1,253 TAF **Drainage Area = 904 sq. mi.** **Data Source: CDEC**

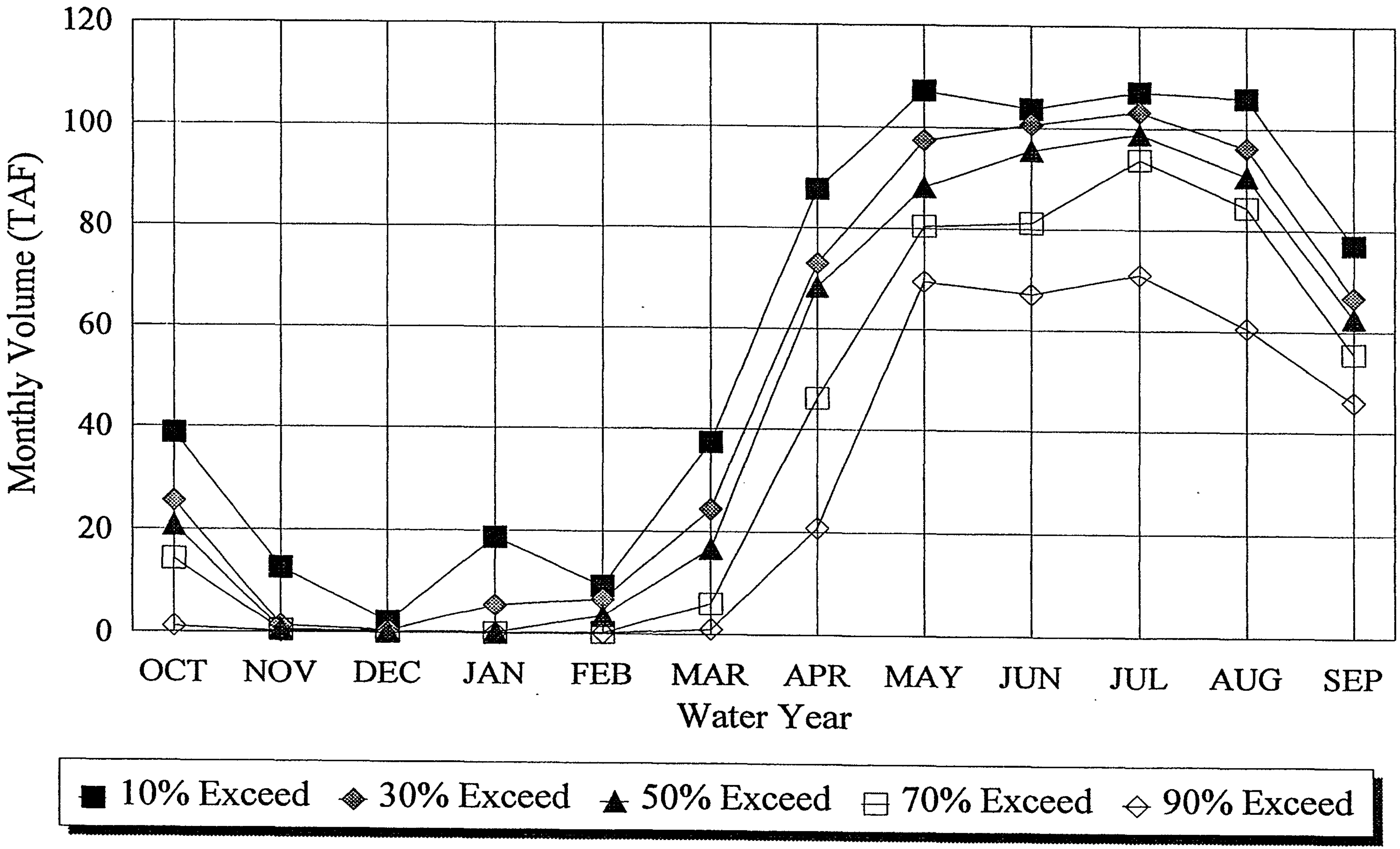
Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	141	205	316	341	372	421	404	384	306	219	149	124
10%	269	286	346	373	373	423	433	423	402	340	287	296
20%	376	365	386	493	726	769	715	634	568	480	412	378
30%	715	735	763	777	800	903	975	909	857	769	699	672
40%	972	937	920	922	938	986	1229	1279	1207	1124	1055	989
50%	1352	1431	1430	1444	1445	1384	1359	1546	1598	1519	1432	1358
60%	1451	1449	1542	1633	1866	1850	1780	1710	1636	1568	1466	1443
70%	1515	1532	1567	1683	1868	1903	1921	1900	1823	1668	1540	1508
80%	1826	1873	1885	1867	1880	1942	1931	2028	2059	1986	1910	1841
90%	1937	1943	1920	1884	1904	2037	1934	2031	2254	2164	2031	1948
100%	1971	2036	2052	1911	1995	2071	2091	2213	2369	2325	2142	2024

C-003304

Figure 73

Stanislaus River Monthly Diversion Exceedence

Historic (1962-1992)

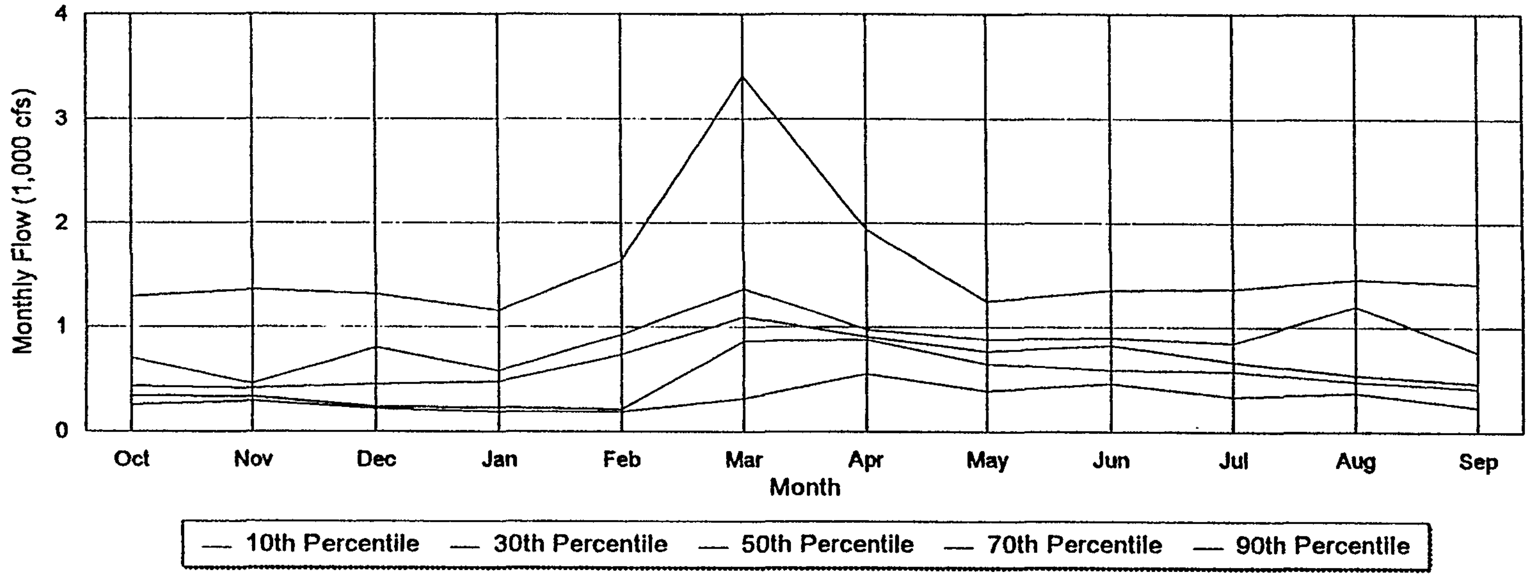


C-003305

C-003305

C-003306

Figure 74 Distribution of Historic Monthly Flow in the Stanislaus River at Ripon for Water Years 1981-1991



Historic Monthly Flow in the Stanislaus River at Ripon (cfs) for the 1981-1991 Period of Record

Average Flow = 938 cfs **Drainage Area = 1,075 sq. mi.** **Data Source: USGS**

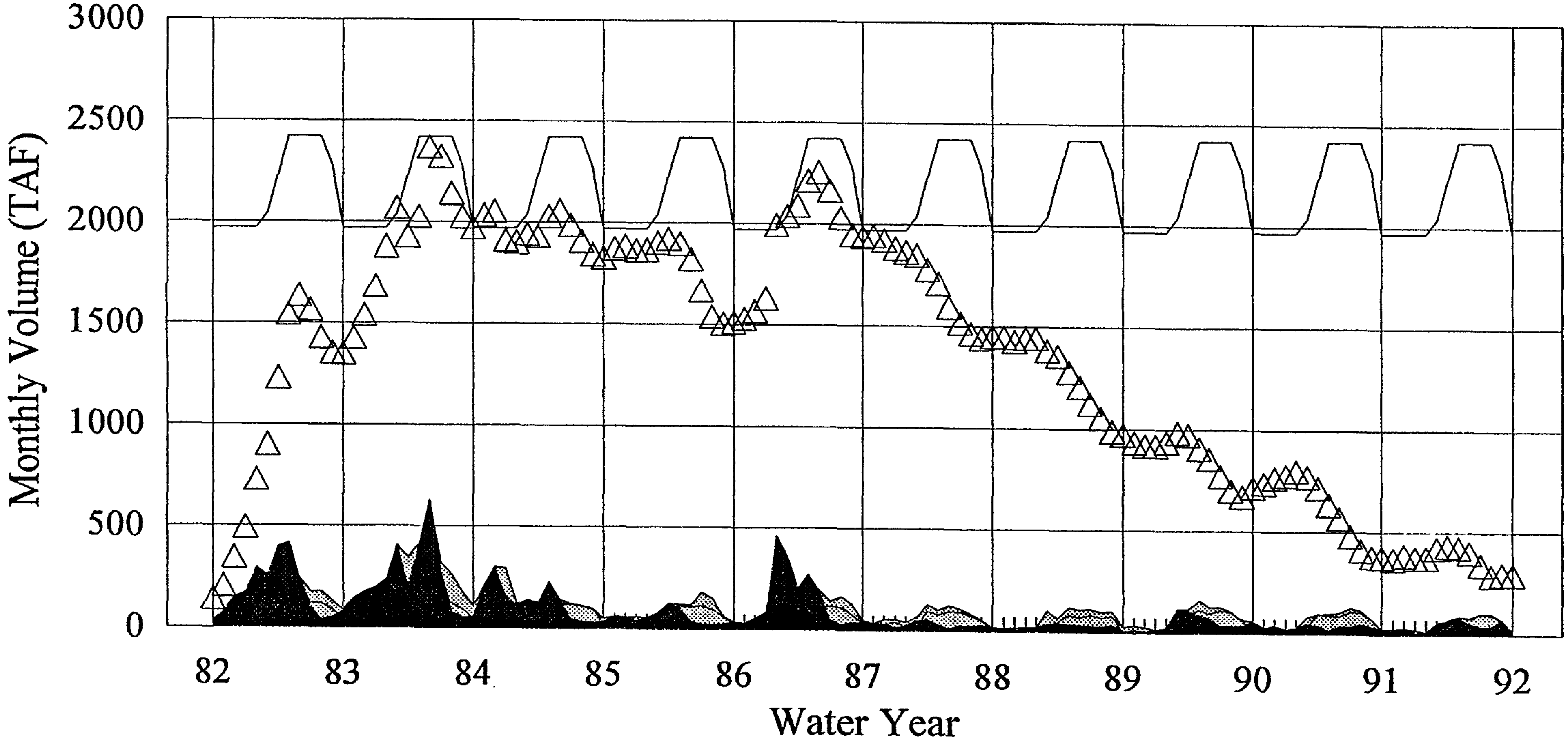
Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	237	248	201	178	183	260	251	381	218	315	215	207	192
10%	251	288	215	185	187	312	548	389	457	330	372	234	282
20%	322	316	216	208	201	562	766	552	480	458	407	321	314
30%	341	334	231	229	213	860	877	645	587	569	477	414	435
40%	371	373	234	245	232	1,082	882	649	601	608	528	420	448
50%	431	413	447	473	735	1,089	908	765	820	666	533	460	532
60%	479	414	470	569	809	1,151	965	838	891	757	748	708	568
70%	702	455	798	577	925	1,365	973	880	895	845	1,194	757	646
80%	799	536	893	1,049	1,143	1,413	1,107	1,091	1,229	1,336	1,258	1,296	967
90%	1,285	1,354	1,311	1,150	1,635	3,418	1,944	1,246	1,348	1,361	1,454	1,411	1,257
100%	1,775	2,395	4,923	4,593	1,759	4,886	5,047	4,196	3,269	3,633	2,834	2,041	1,844

C—003306

Figure 75

Stanislaus River Flow Allocation

Historical



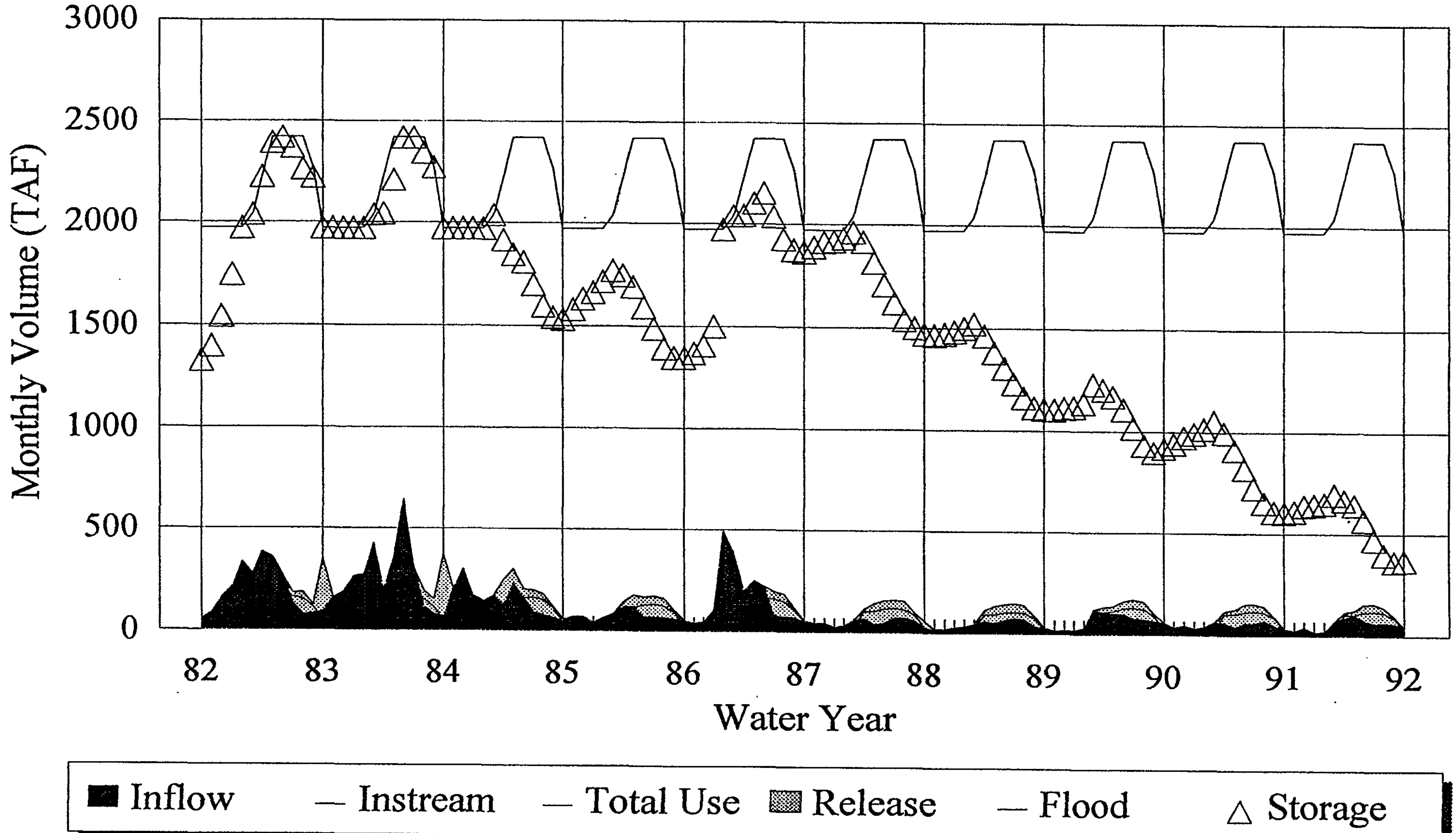
C-003307

C—003307

Figure 76

Stanislaus River Flow Allocation

DWRSIM 472 CALFED No-Action



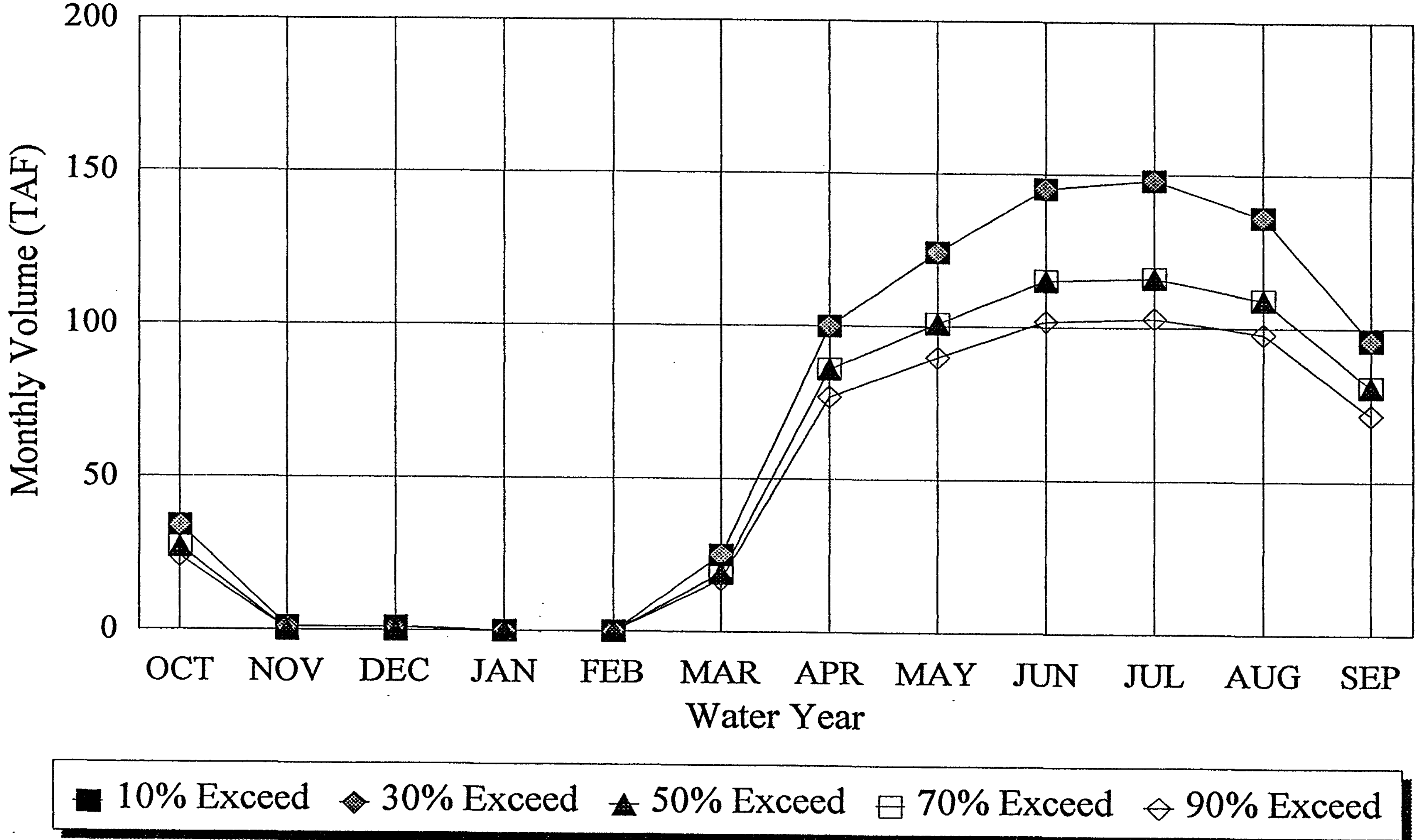
C-003308

C—003308

Figure 77

Stanislaus River Monthly Diversion Exceedence

DWRSIM 472 CALFED No-Action

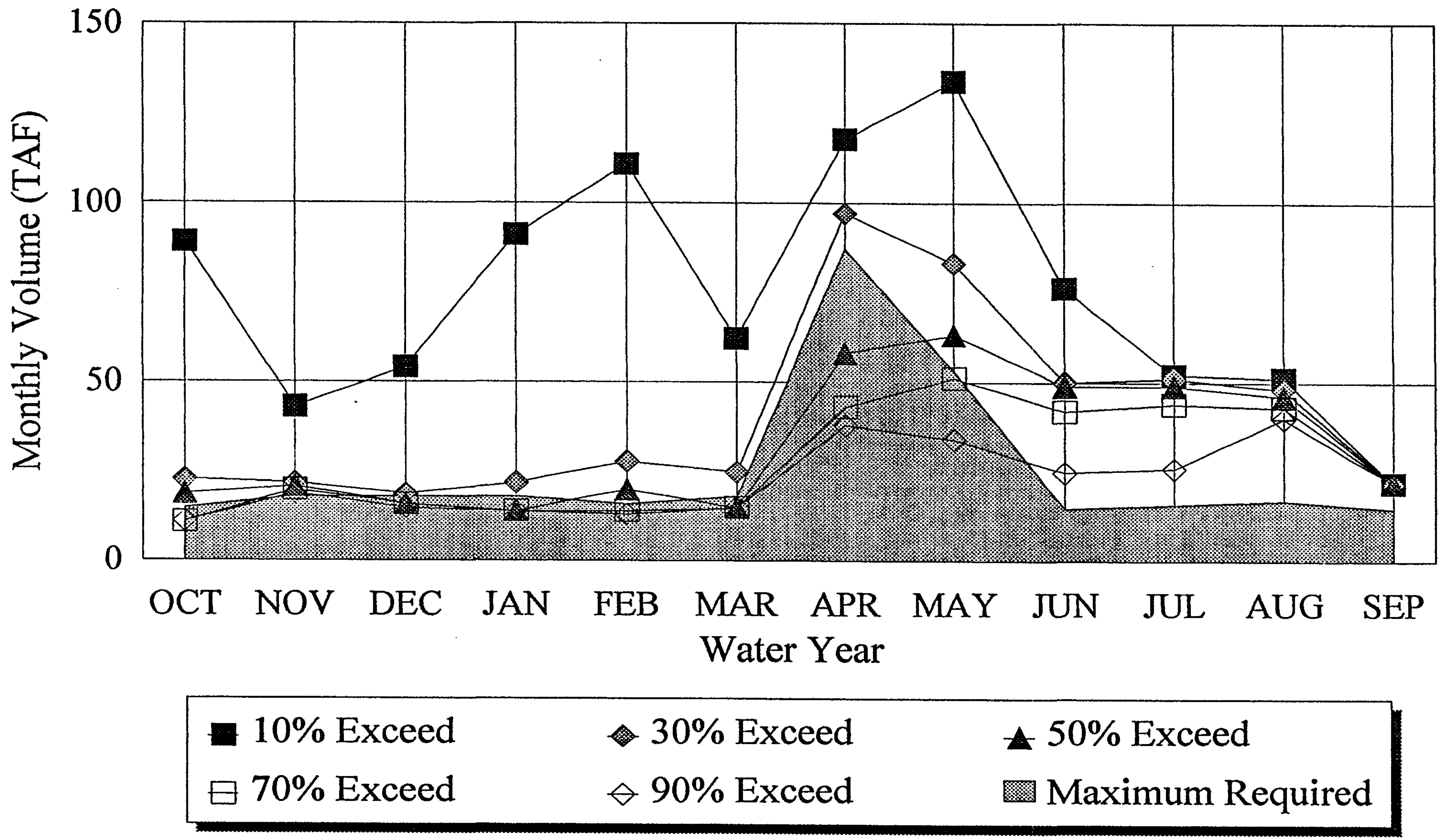


C-003309

Figure 78

Stanislaus River Monthly Flow Exceedence

DWRSIM 472 CALFED No-Action



C-003310

C-003310

Figure 79

Stanislaus River Annual Water Allocation

DWRSIM 472 CALFED No-Action

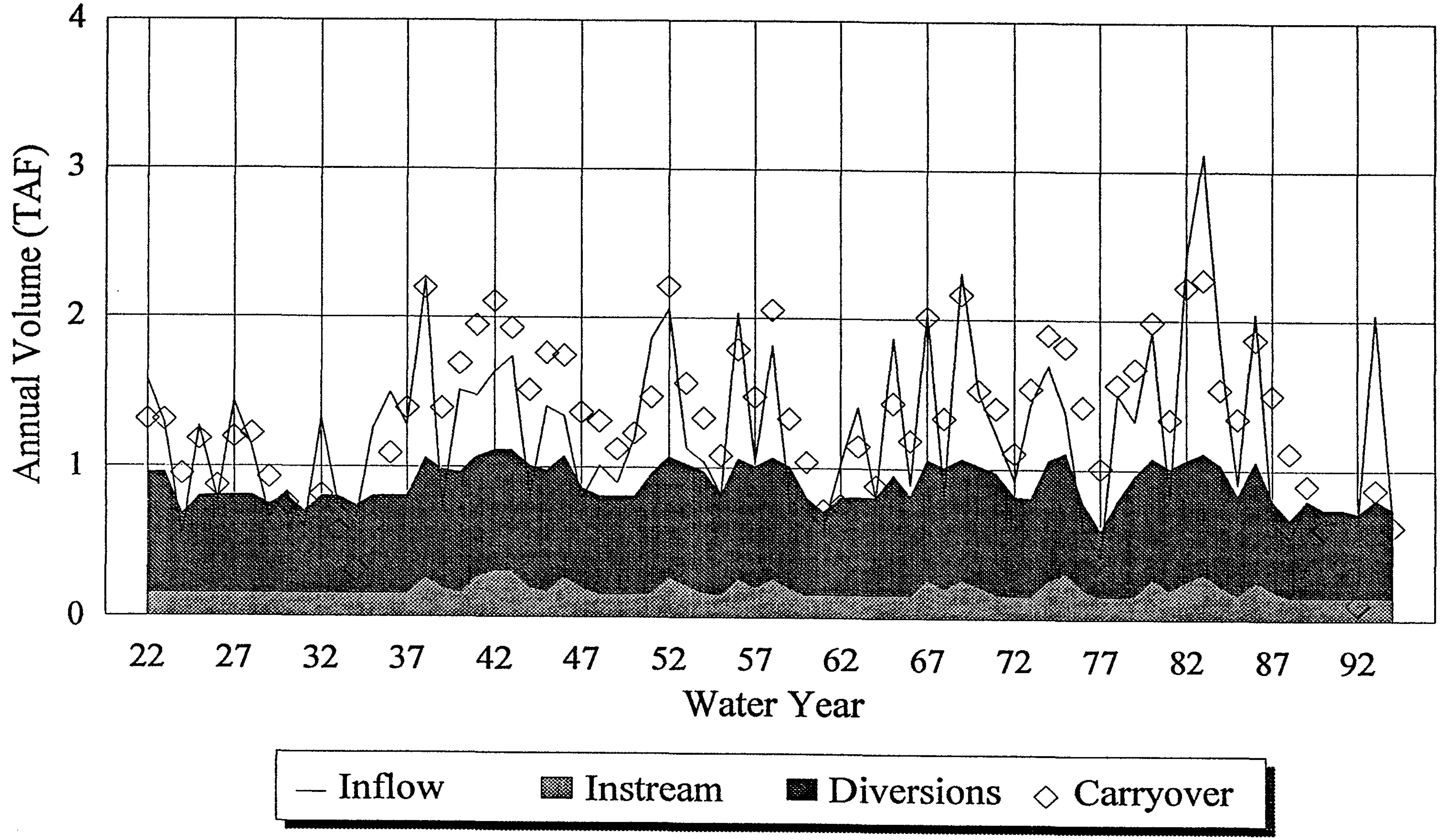
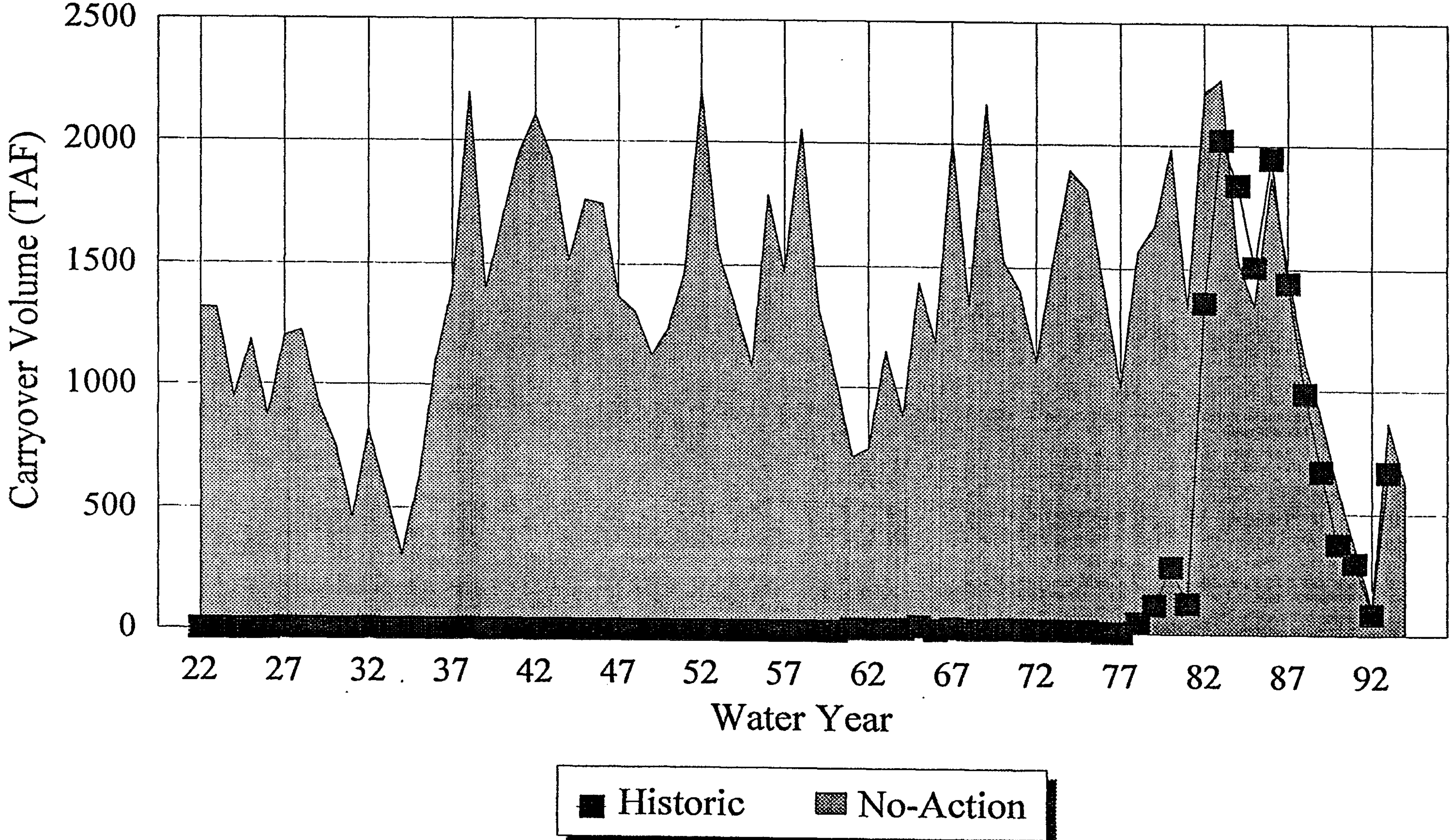


Figure 80

New Melones Reservoir Carryover Storage

Historical and No-Action



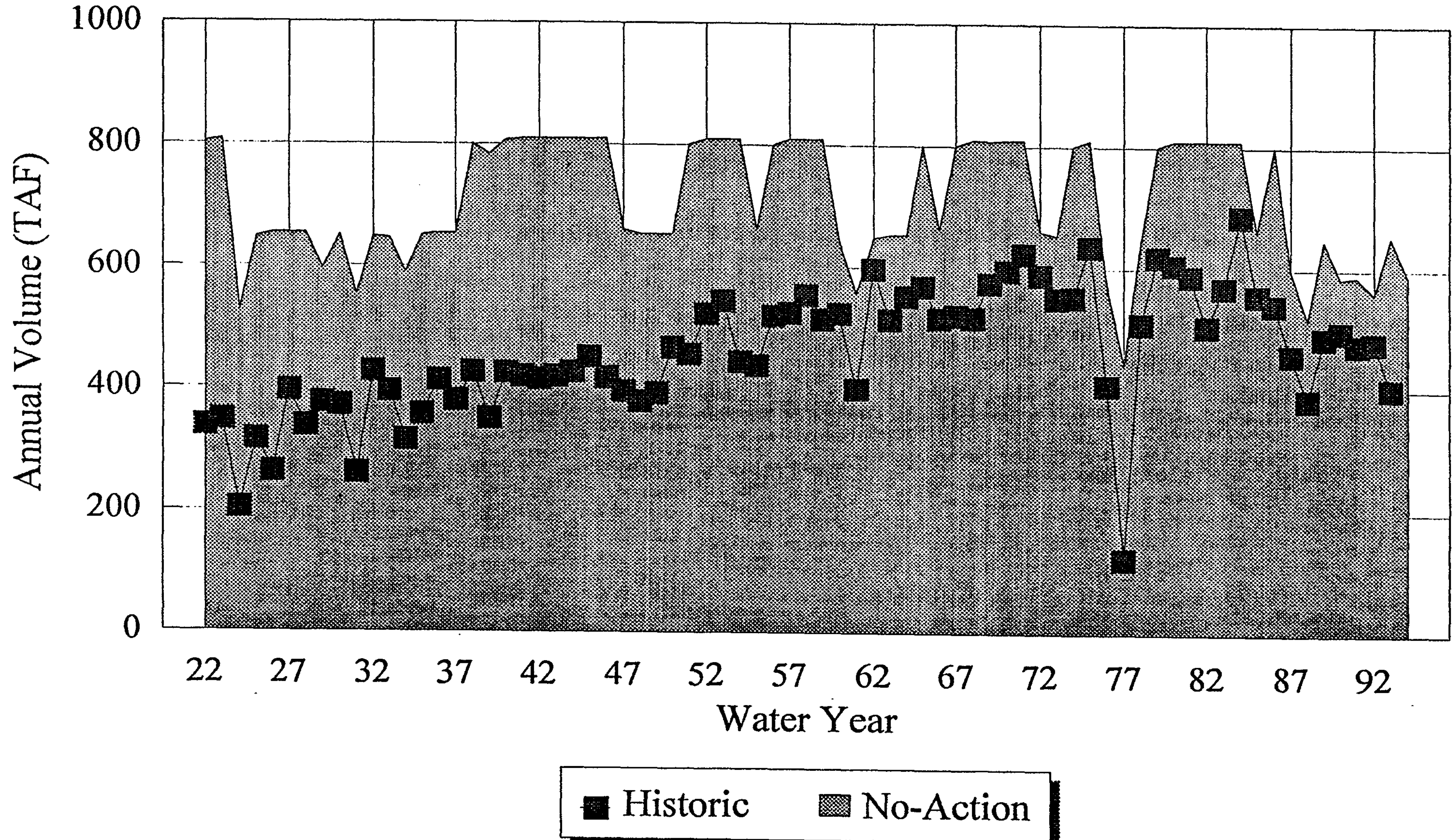
C-003312

C-003312

Figure 81

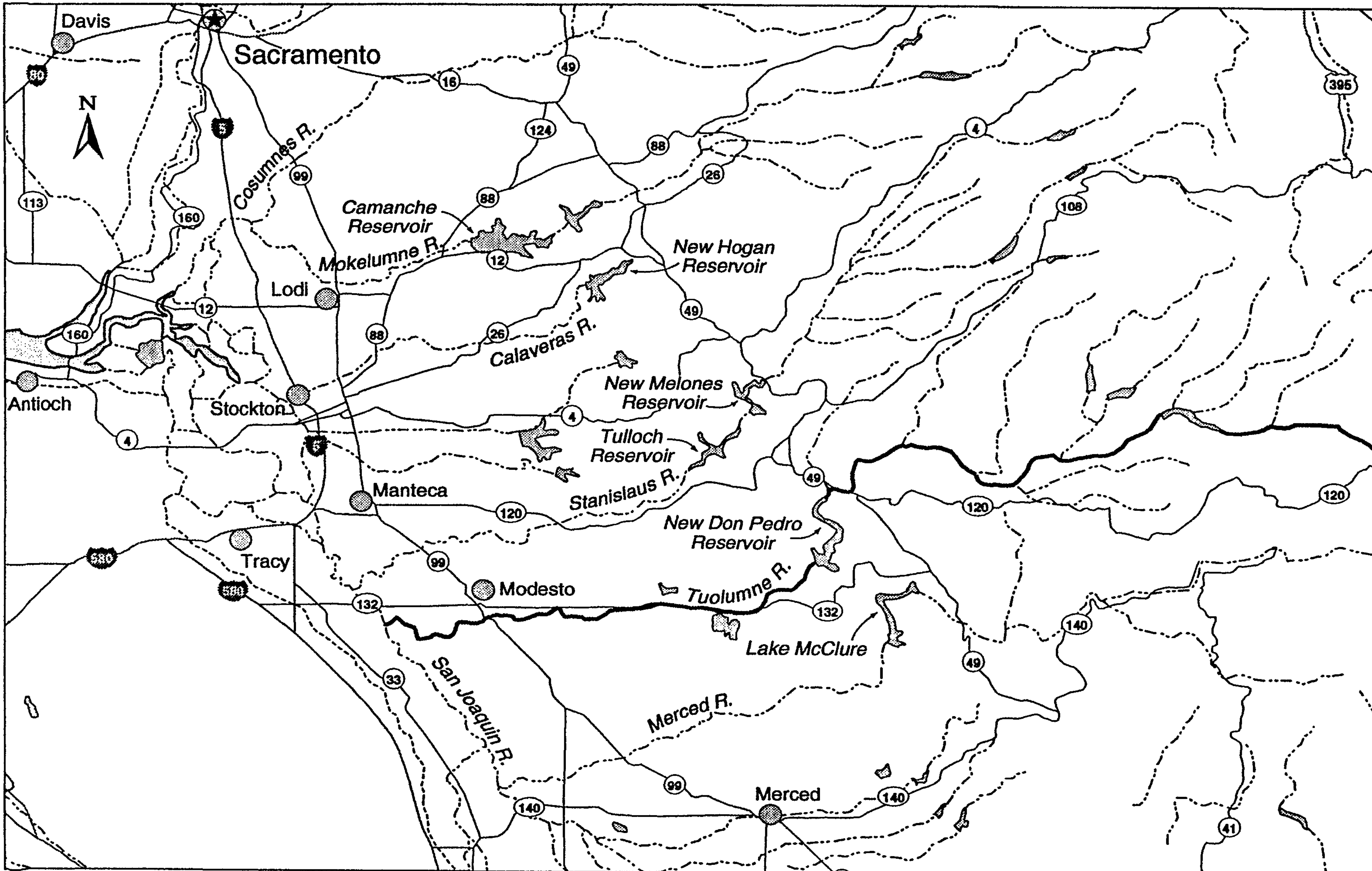
Stanislaus River Diversions

Historical and No-Action



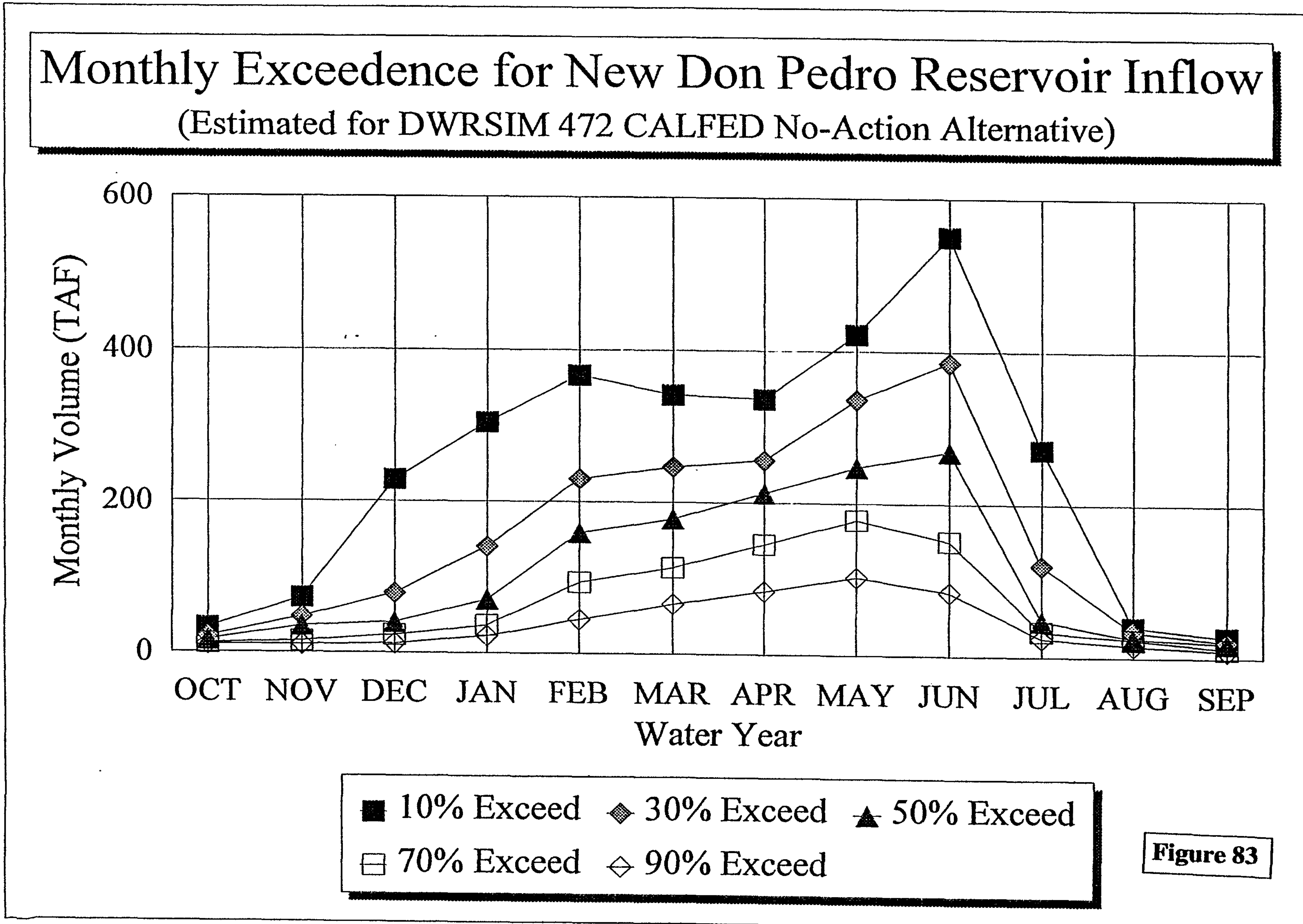
C-003313

C-003313



CALFED BAY-DELTA PROGRAM

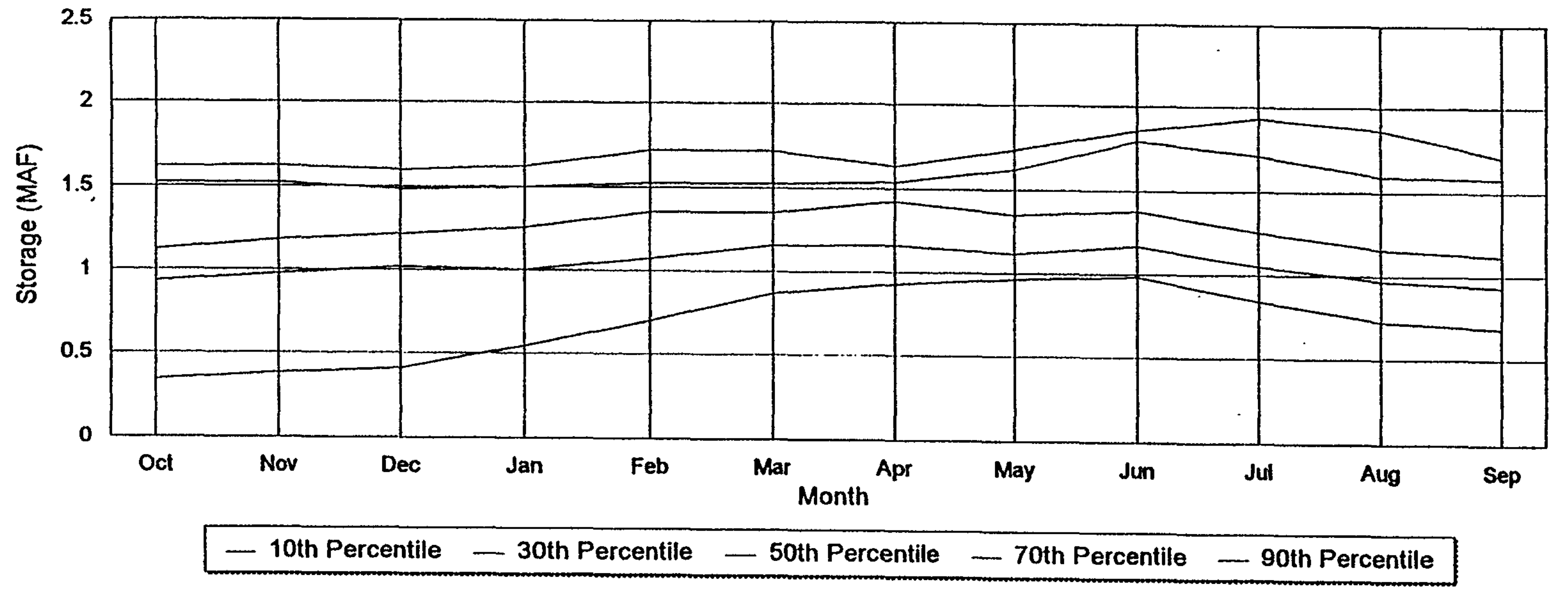
Figure 82
Tuolumne River Basin Water Management Facilities



Monthly Exceedence for New Don Pedro Reservoir Inflow
(Estimated for DWRSIM 472 CALFED No-Action Alternative)
600
400
200
0
Monthly Volume (TAF)
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Water Year
10% Exceed
30% Exceed
50% Exceed
70% Exceed
90% Exceed

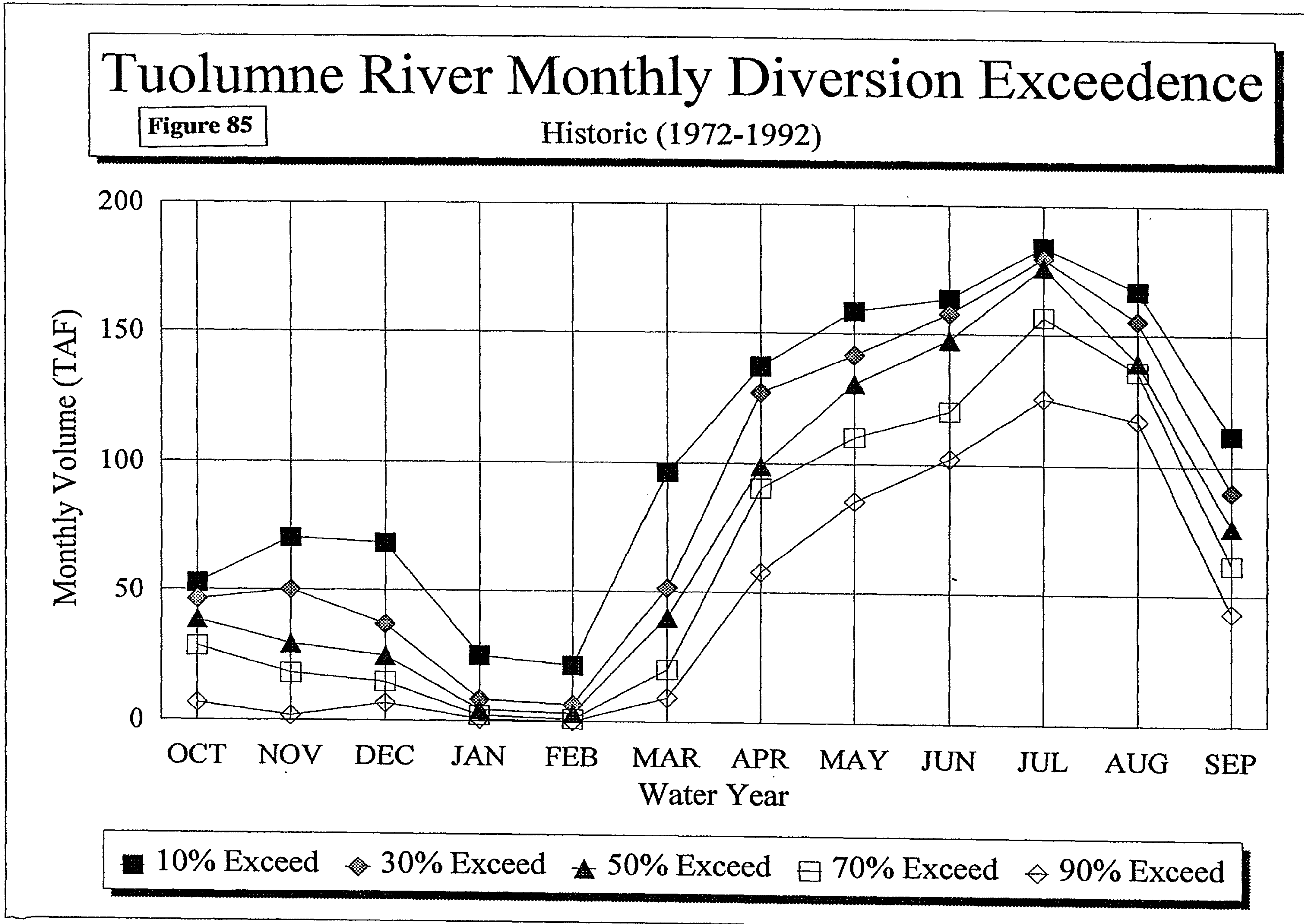
Figure 83

Figure 84 Distribution of End-of-Month Storage in New Don Pedro Reservoir for Water Years 1972-1992



Historic End-of-Month Storage in New Don Pedro Reservoir (TAF) for the 1972-1992 Period of Record
Average Storage = 1,247 TAF **Drainage Area = 1,533 sq. mi.** **Data Source: CDEC**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	304	322	365	511	576	542	524	525	458	383	320	307
10%	343	385	412	549	701	873	931	964	984	845	728	687
20%	905	877	876	941	984	1025	1085	1101	1017	937	920	913
30%	934	976	1020	1005	1079	1160	1165	1122	1172	1056	969	934
40%	975	1011	1079	1172	1229	1276	1205	1249	1238	1118	998	992
50%	1125	1183	1218	1258	1352	1353	1424	1350	1376	1257	1159	1119
60%	1404	1367	1312	1386	1480	1476	1464	1470	1611	1651	1457	1461
70%	1521	1523	1485	1497	1527	1528	1537	1615	1793	1711	1588	1575
80%	1562	1569	1525	1523	1565	1613	1589	1630	1832	1762	1677	1606
90%	1615	1619	1597	1618	1721	1720	1631	1733	1855	1936	1864	1705
100%	1677	1713	1767	1697	1753	1885	1782	1826	2006	2017	1935	1747

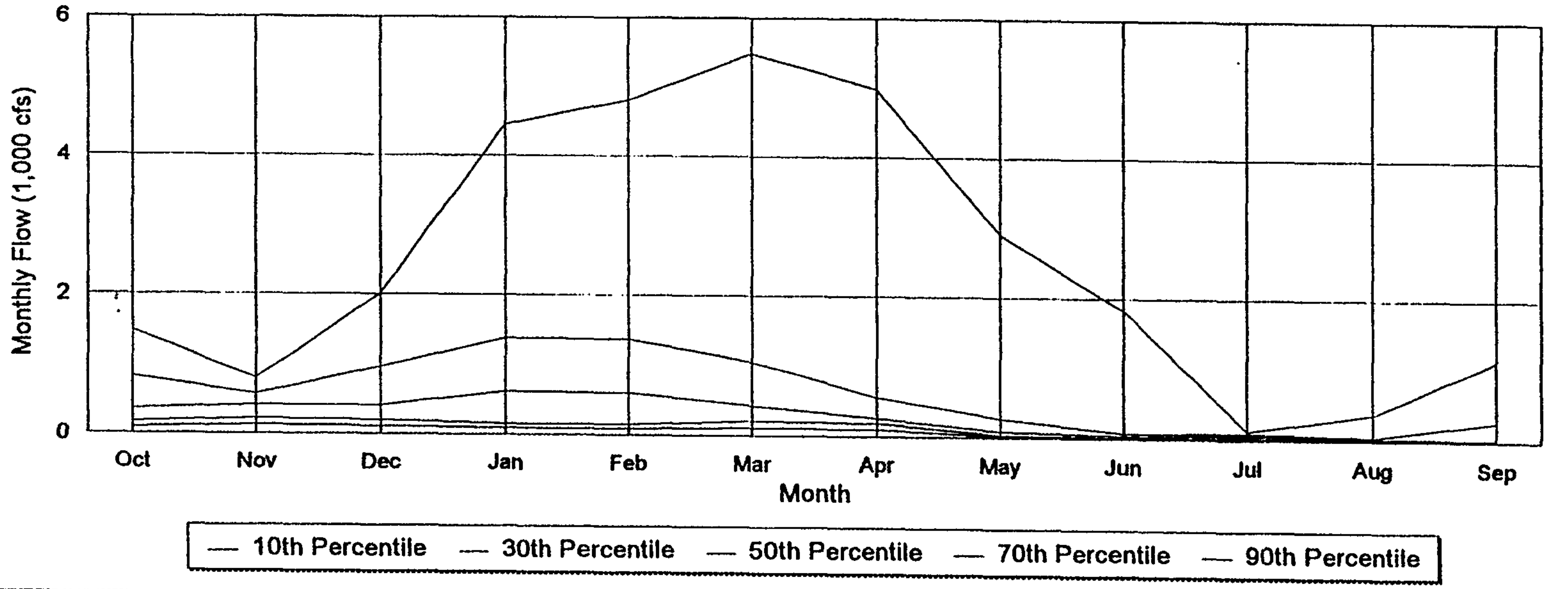


C-003317

C-003317

C-003318

Figure 86 Distribution of Historic Monthly Flow in the Tuolumne River near La Grange for Water Years 1972-1992



Historic Monthly Flow in the Tuolumne River near La Grange (cfs) for the 1972-1992 Period of Record
Average Flow = 879 cfs **Drainage Area = 1,538 sq. mi.** **Data Source: USGS**

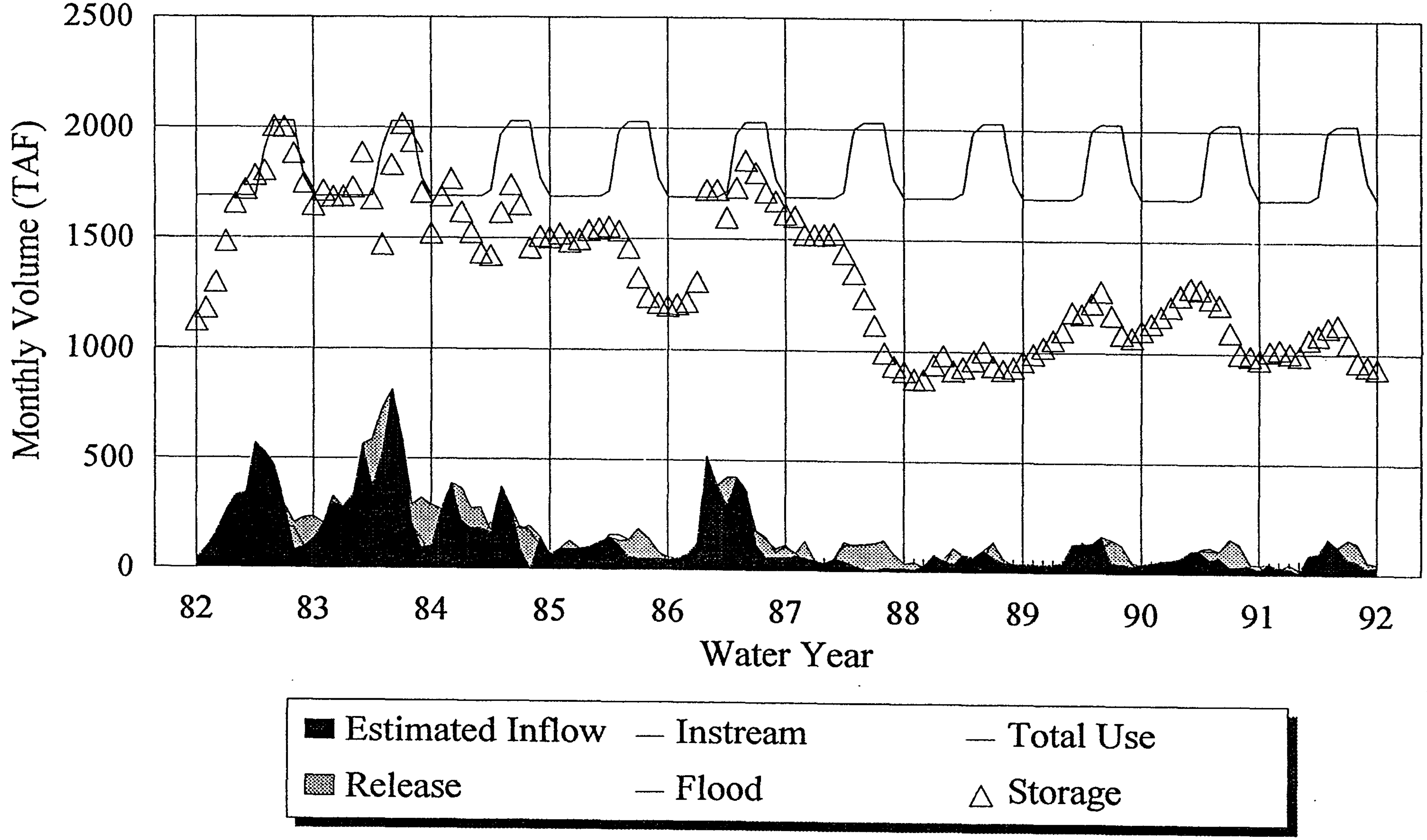
Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	1	8	10	10	22	94	41	9	8	7	6	4	61
10%	91	127	105	93	96	113	102	12	10	13	10	10	78
20%	156	209	173	141	117	158	116	18	17	17	20	16	83
30%	175	222	199	159	152	209	189	32	19	19	23	21	164
40%	318	257	381	474	432	349	239	44	30	45	32	26	283
50%	365	403	403	622	614	428	265	86	48	56	33	29	360
60%	530	421	643	1,363	1,066	536	358	256	58	71	44	49	376
70%	825	568	959	1,379	1,370	1,059	565	276	80	89	54	276	561
80%	1,240	770	1,305	2,167	2,696	2,983	916	2,279	245	110	94	622	1,134
90%	1,483	798	2,006	4,452	4,806	5,482	4,984	2,903	1,833	123	370	1,142	1,497
100%	4,187	905	4,327	5,563	5,265	6,636	8,900	9,744	5,161	3,808	1,747	3,491	3,465

C—003318

Figure 87

Tuolumne River Flow Allocation

Historical

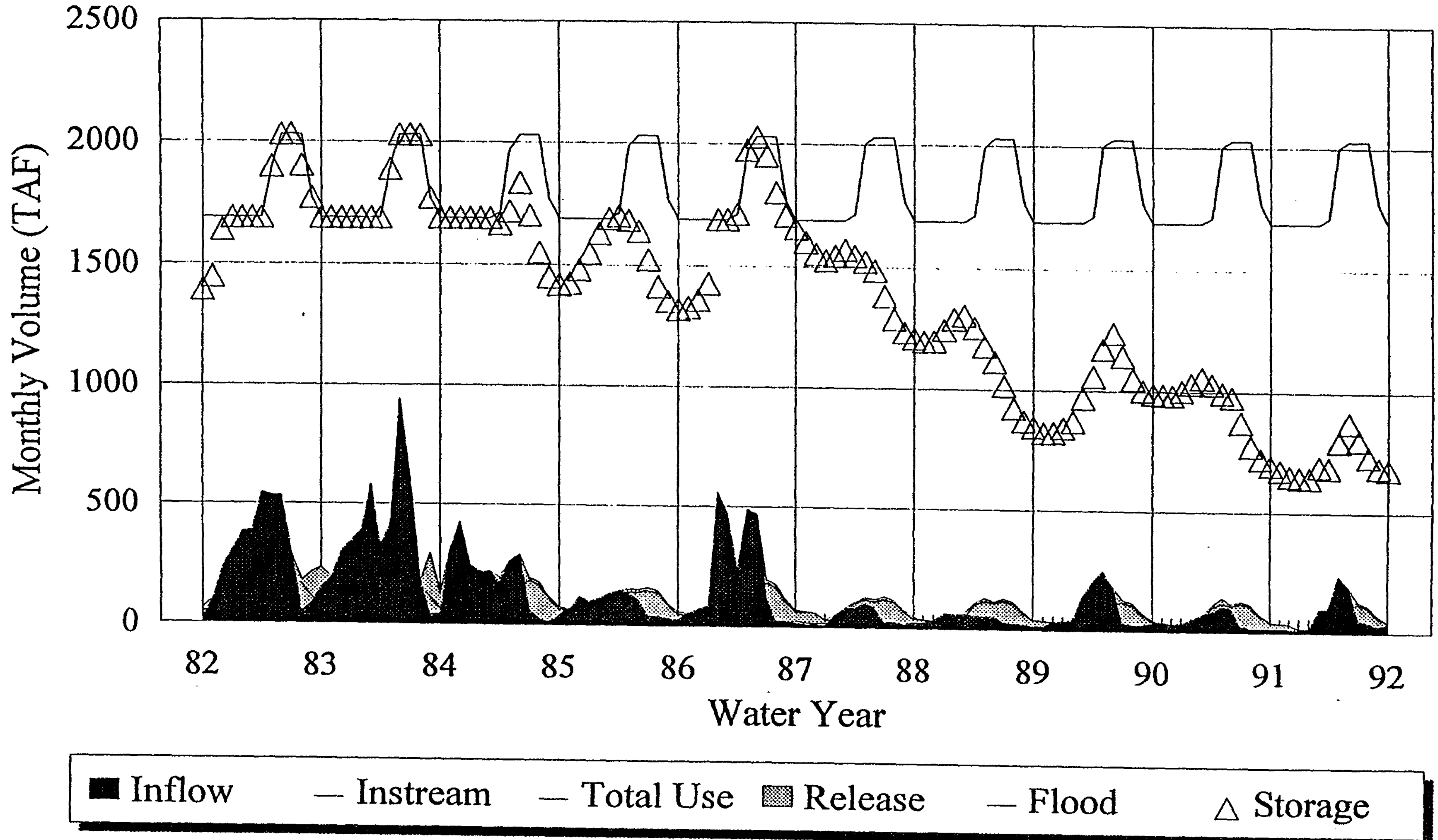


C—003319

Figure 88

Tuolumne River Flow Allocation

DWRSIM 472 CALFED No-Action



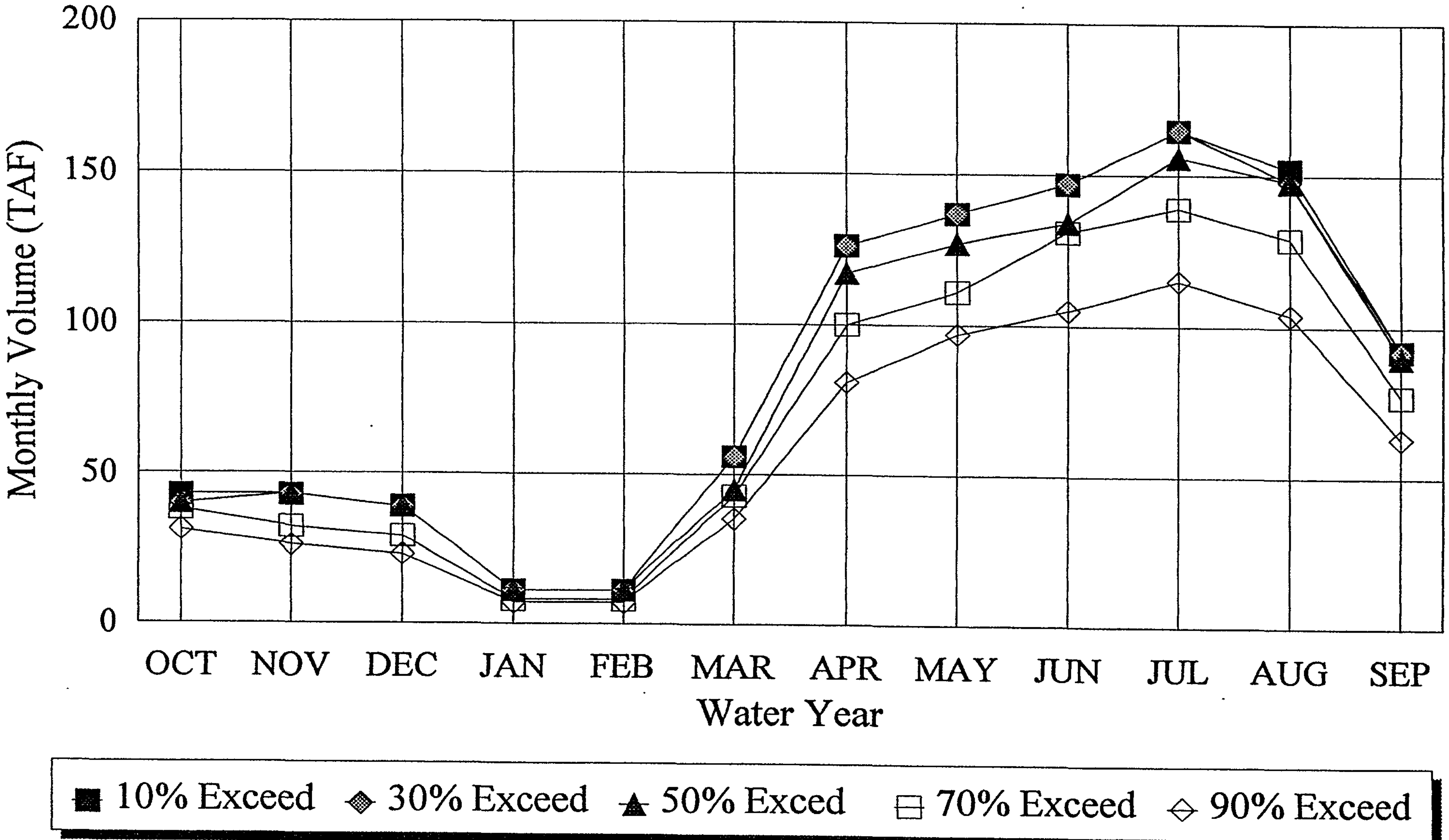
C-003320

C —0 0 3 3 2 0

Tuolumne River Monthly Diversion Exceedence

Figure 89

DWRSIM 472 CALFED No-Action

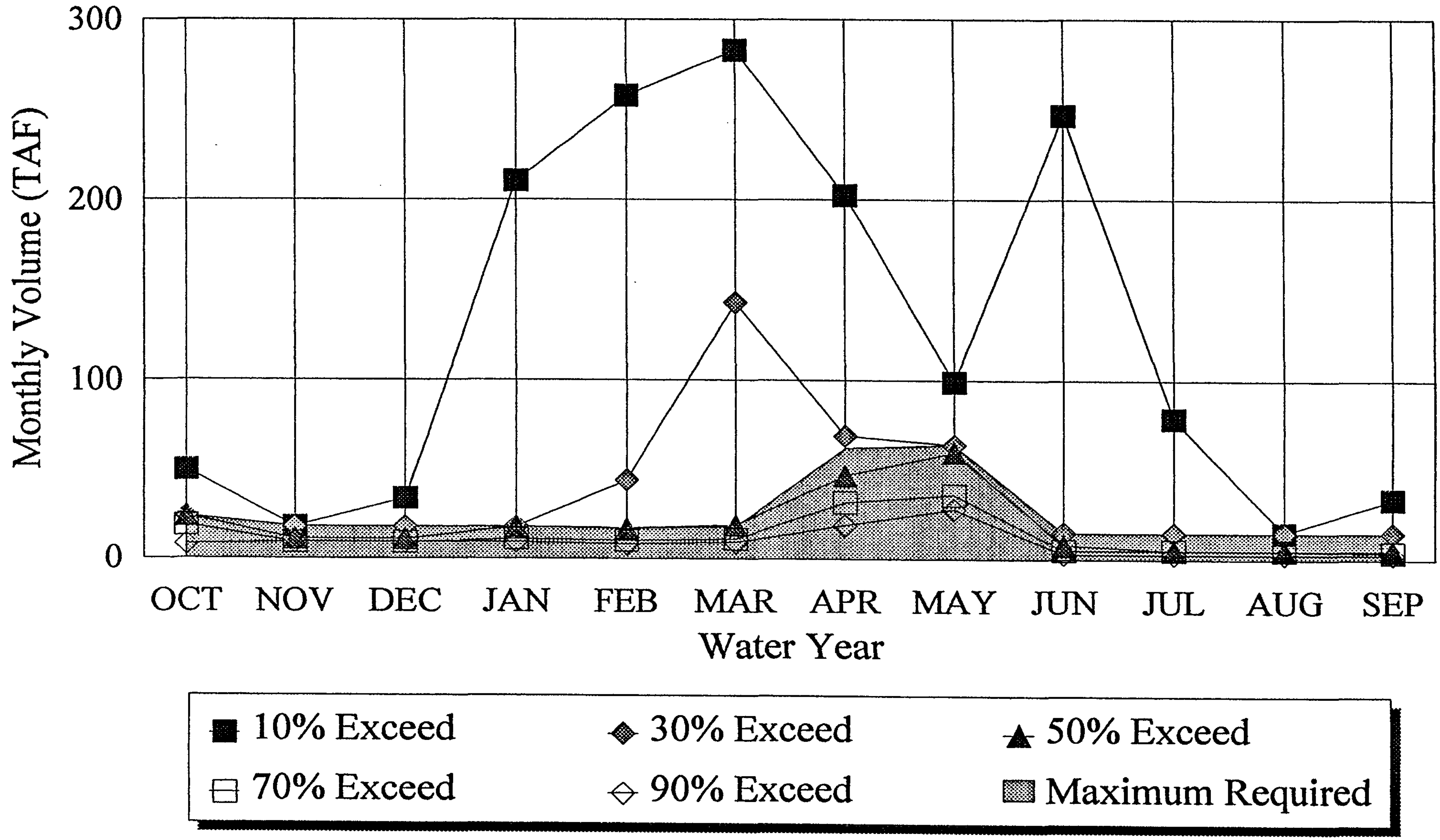


C-003321

Figure 90

Tuolumne River Monthly Flow Exceedence

DWRSIM 472 CALFED No-Action



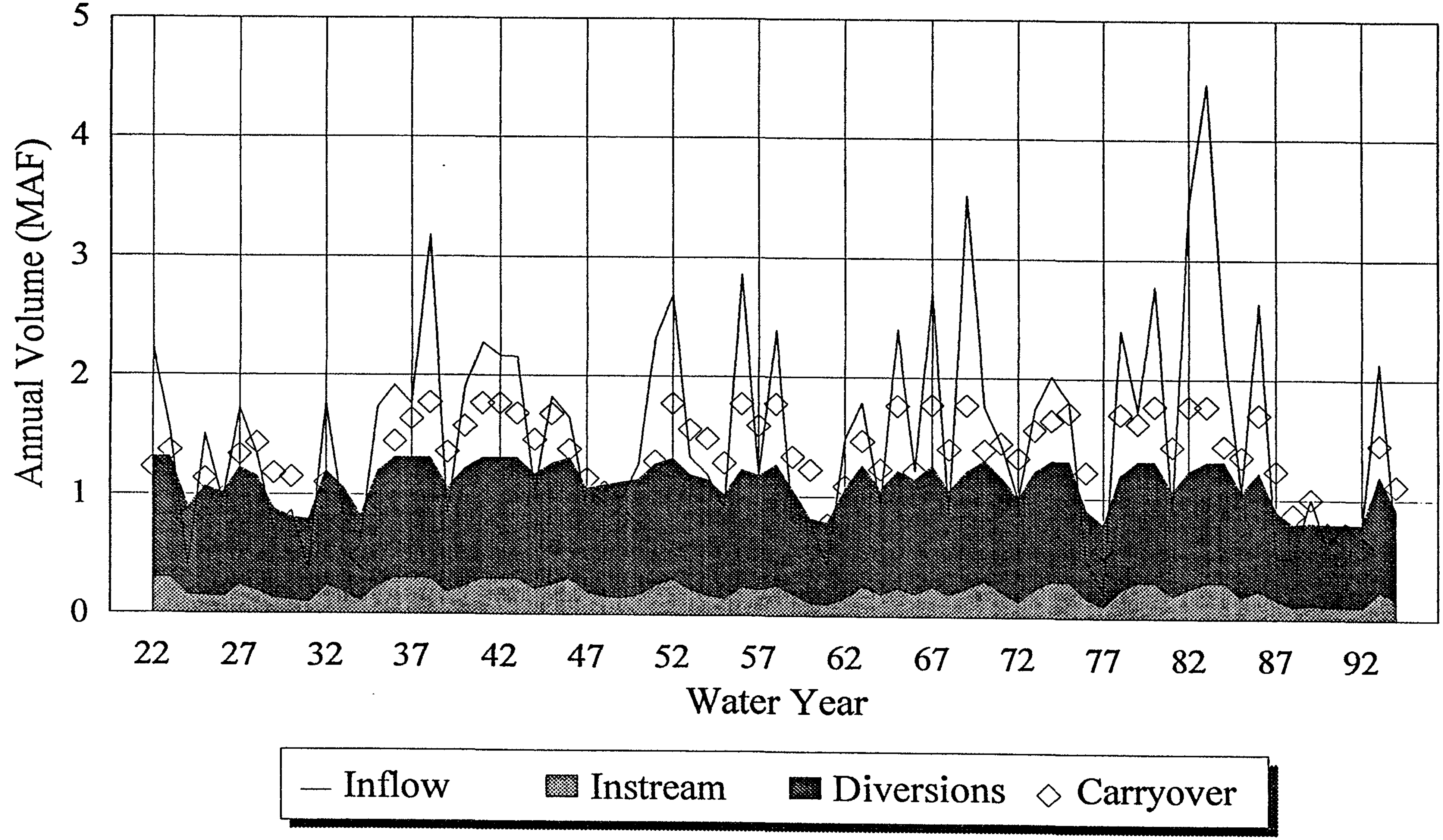
C-003322

C—003322

Figure 91

Tuolumne River Annual Water Allocation

DWRSIM 472 CALFED No-Action



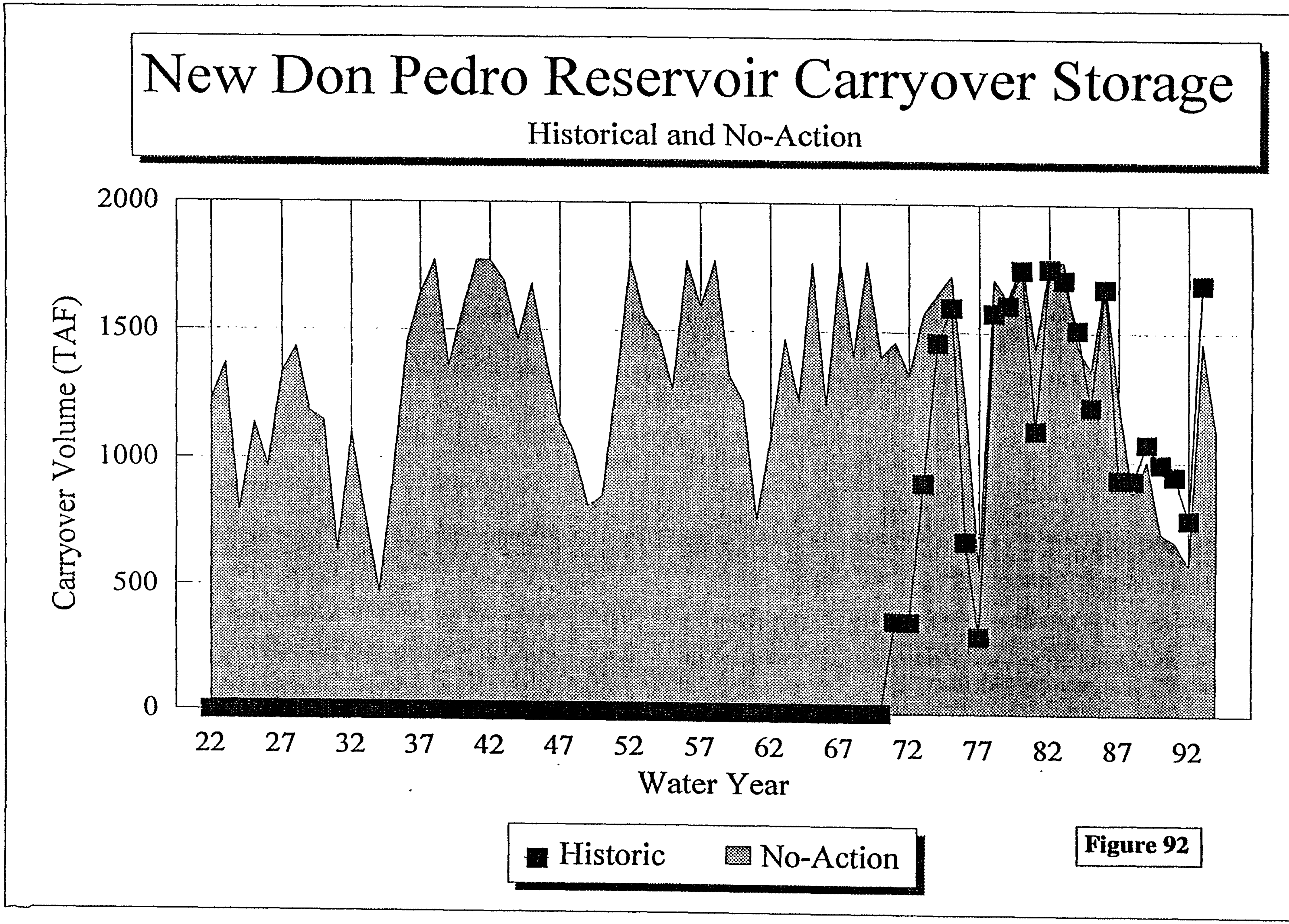


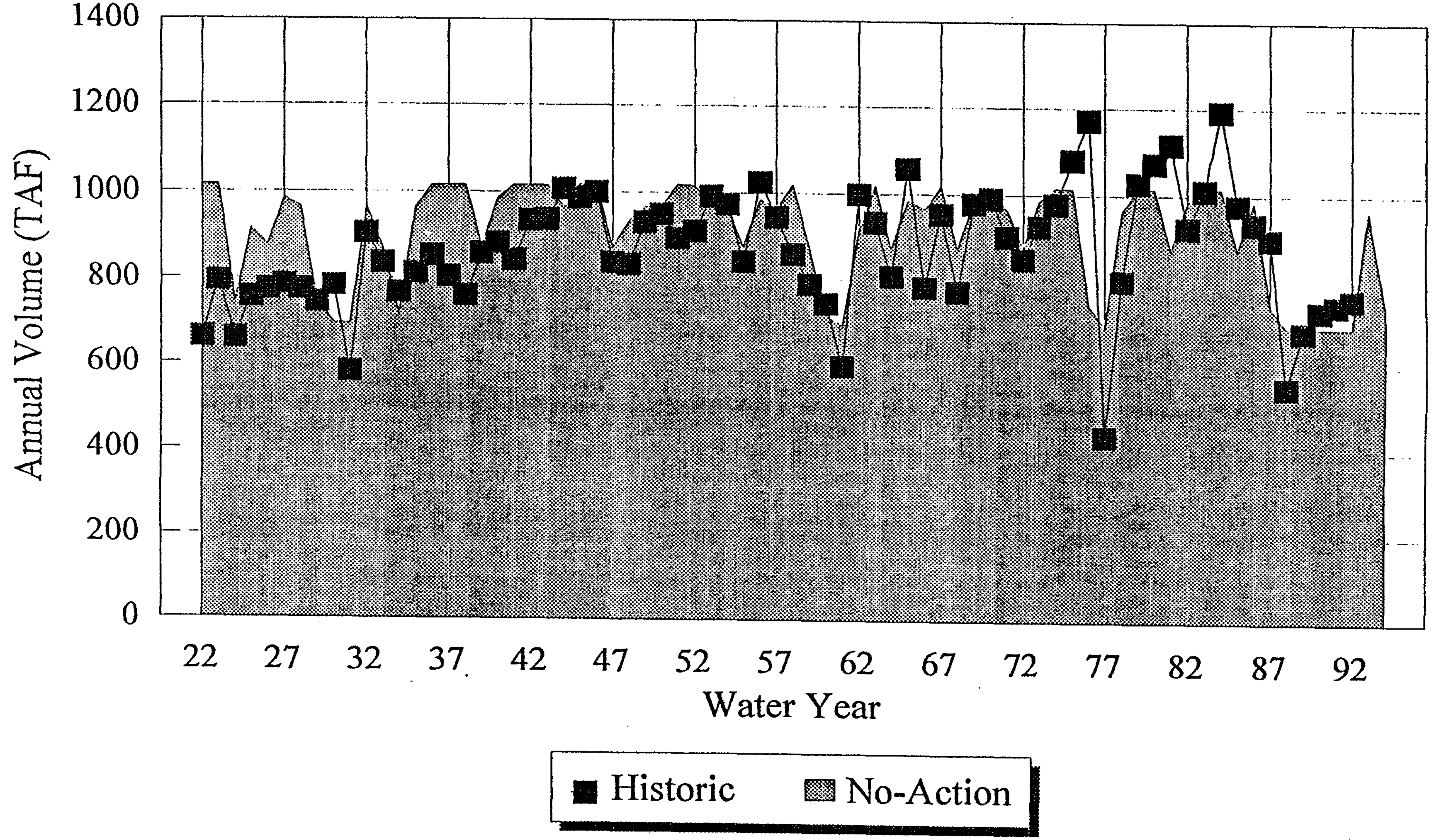
Figure 92

C-003324

Figure 93

Modesto ID and Turlock ID Diversions

Historical and No-Action



C-003325

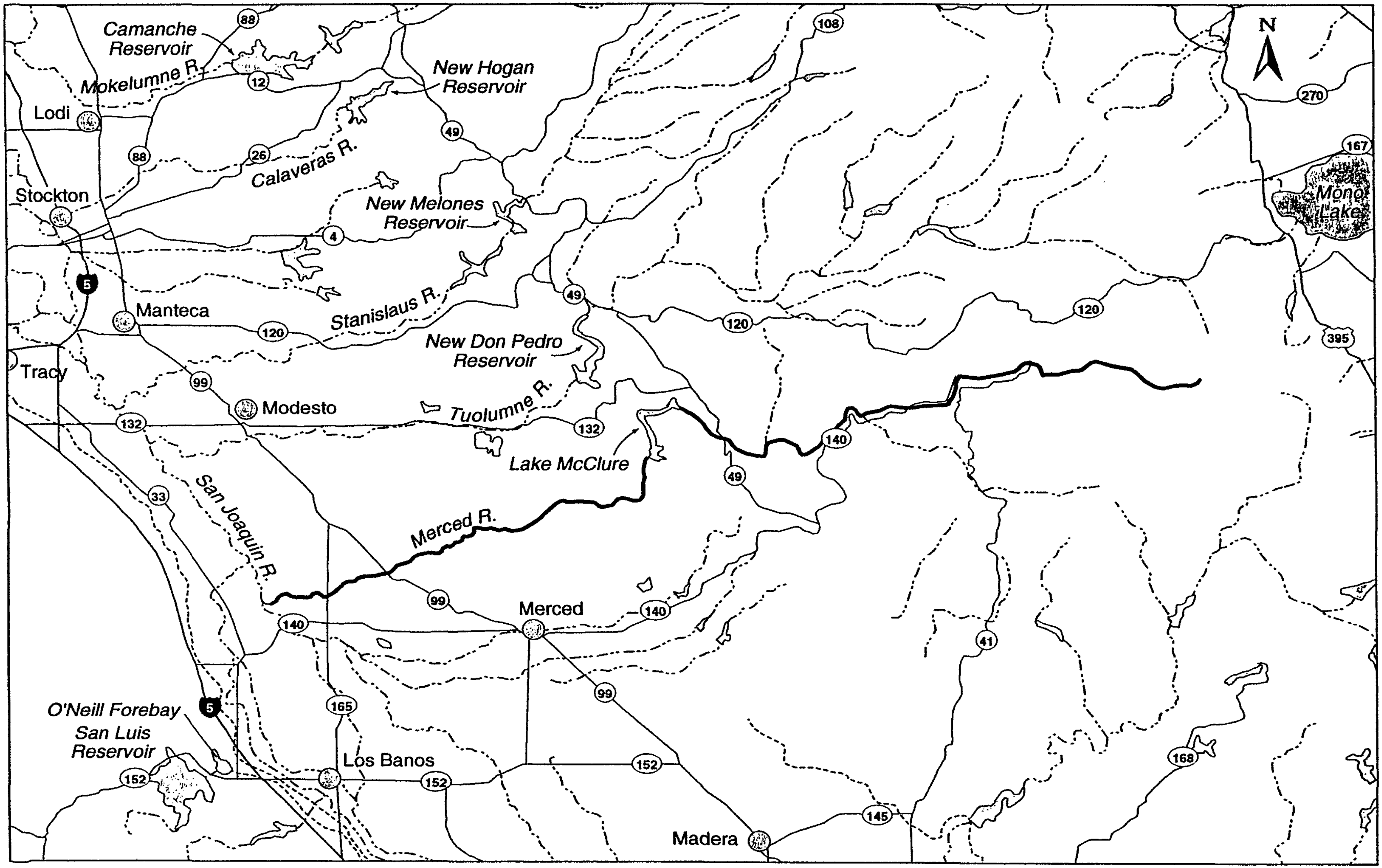


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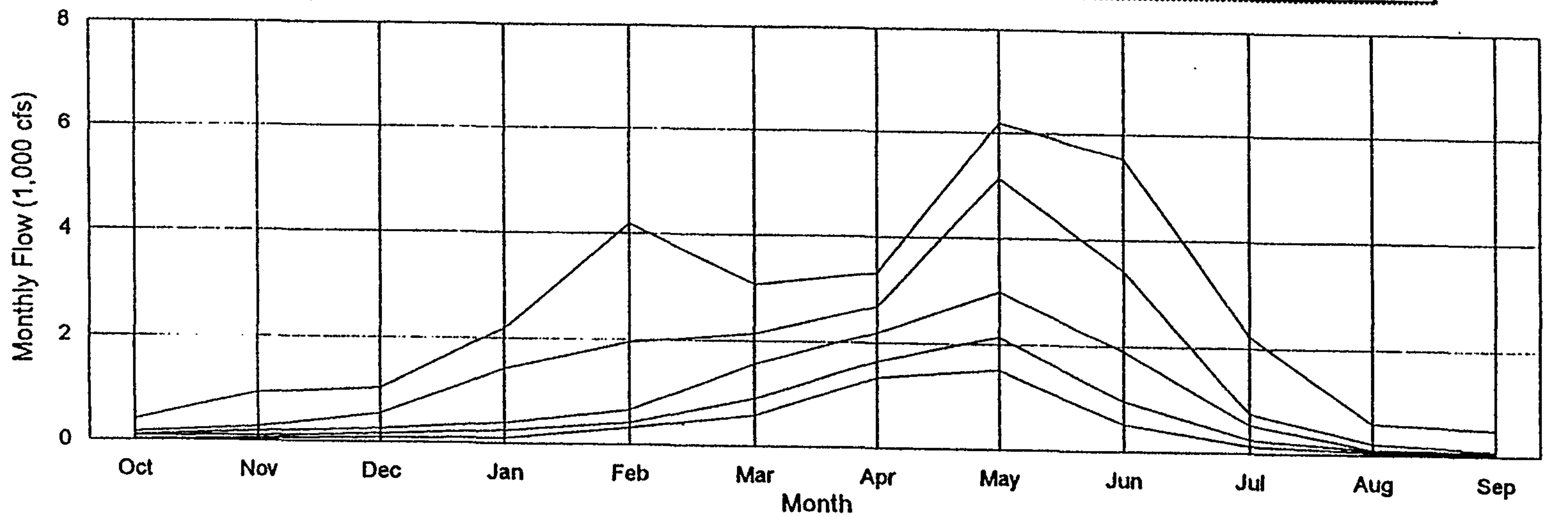
Figure 94
Merced River Basin Water Management Facilities

Figure 95

Distribution of Unimpaired Monthly Flow in the Merced River at Lake McClure for Water Years 1972-1992

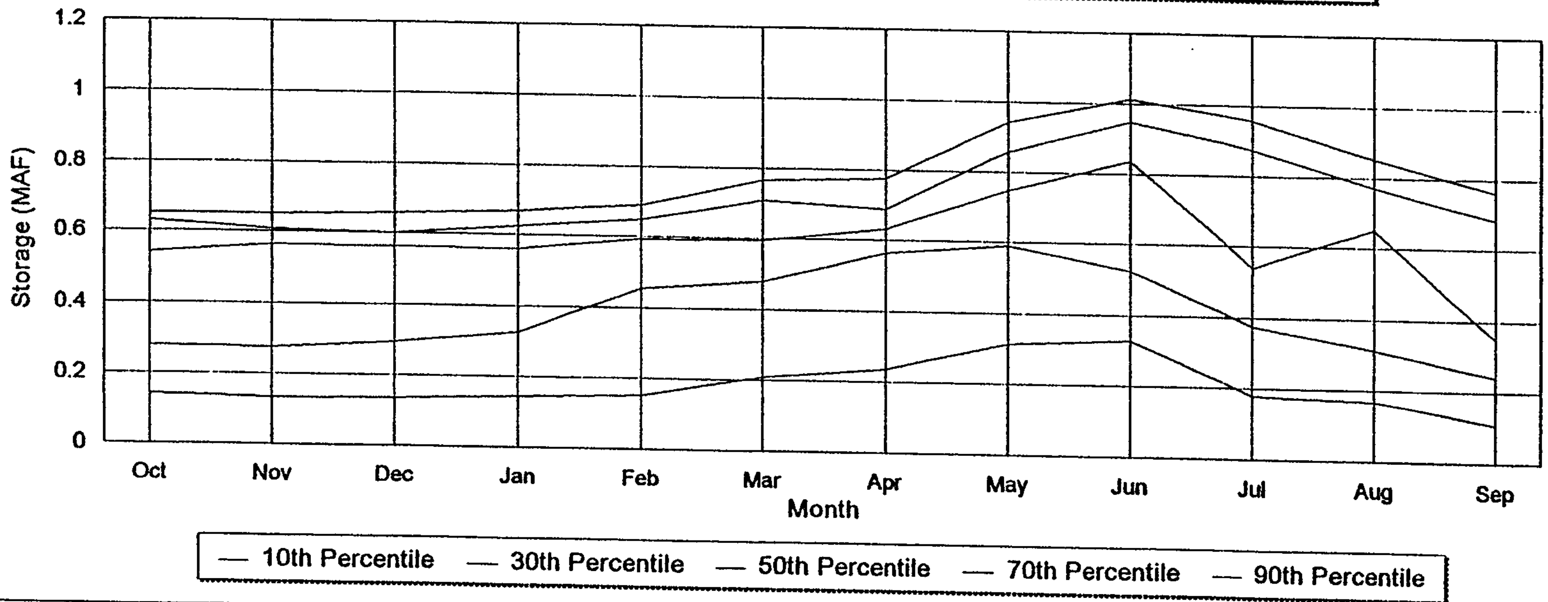


Unimpaired Monthly Flow in the Merced River at Lake McClure (cfs) for the 1972-1992 Period of Record
Average Flow = 1,322 cfs **Drainage Area = 1,037 sq. mi.** **Data Source: DWR**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	0	17	16	49	54	130	521	634	319	98	16	0	151
10%	16	50	81	98	324	585	1,344	1,513	521	130	49	17	299
20%	65	84	146	195	378	829	1,563	1,708	807	195	81	34	414
30%	81	101	163	244	417	911	1,647	2,147	958	260	81	50	502
40%	98	185	211	342	591	1,334	2,050	2,716	1,227	374	98	67	556
50%	98	185	260	390	666	1,561	2,202	2,992	1,916	537	98	84	566
60%	130	252	342	732	1,408	1,870	2,218	4,651	2,605	602	195	84	1,112
70%	163	269	553	1,431	1,945	2,147	2,689	5,139	3,412	764	211	101	1,134
80%	244	471	651	1,578	2,665	2,537	2,891	5,595	4,420	1,041	276	202	1,559
90%	407	941	1,041	2,196	4,177	3,074	3,311	6,196	5,546	2,228	585	487	1,754
100%	829	1,916	3,318	4,326	6,518	6,017	7,210	6,798	11,024	5,725	1,578	790	2,786

Figure 96

Distribution of End-of-Month Storage in Lake McClure for Water Years 1971-1991



Historic End-of-Month Storage in Lake McClure (TAF) for the 1971-1991 Period of Record
Average Storage = 532 TAF **Drainage Area = 1,037 sq. mi.** **Data Source: CDEC**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	89	77	77	70	66	148	202	209	200	60	100	67
10%	141	134	134	143	152	208	237	313	326	179	168	108
20%	239	229	218	213	336	326	363	390	388	271	248	148
30%	277	274	293	325	454	478	564	589	526	375	313	242
40%	346	380	434	451	564	556	576	666	640	475	420	293
50%	540	563	561	560	593	595	632	749	837	539	653	347
60%	607	596	589	579	637	660	679	775	922	760	751	592
70%	631	608	600	625	650	709	690	860	950	876	774	685
80%	638	643	632	653	682	727	748	874	977	920	808	707
90%	653	653	658	669	692	767	776	943	1013	959	855	764
100%	686	702	755	734	788	809	881	982	1022	1010	926	772

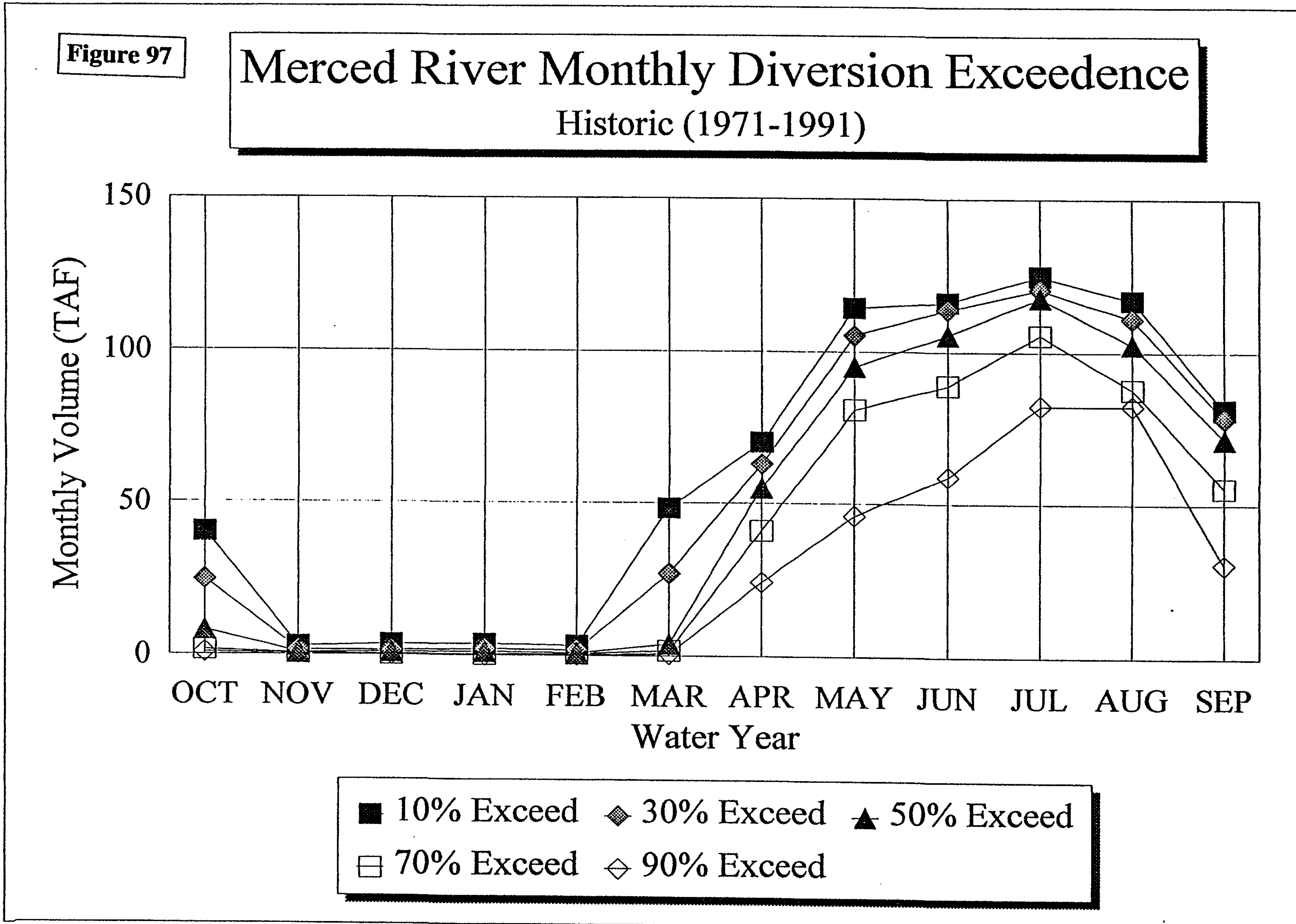
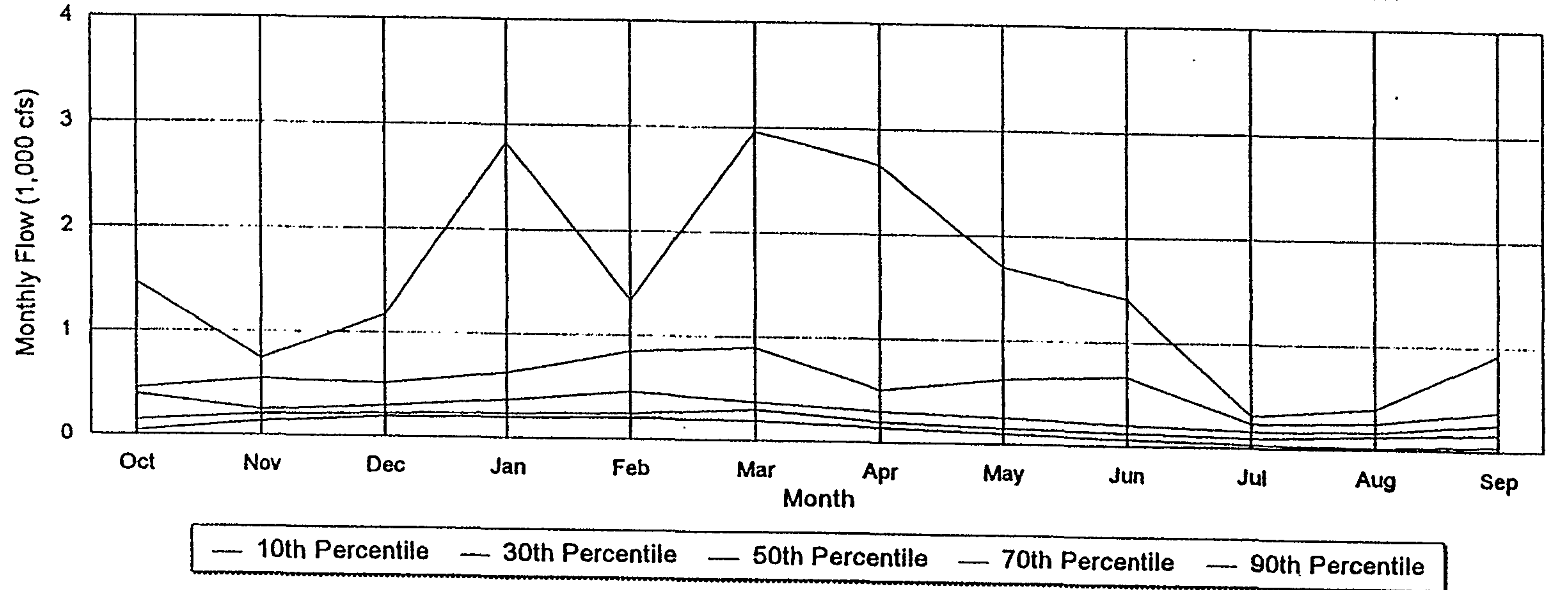


Figure 97
Merced River Monthly Diversion Exceedence
Historic (1971-1991)
150
100
50
0
Monthly Volume (TAF)
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Water Year
10% Exceed
30% Exceed
50% Exceed
70% Exceed
90% Exceed

Figure 98

Distribution of Historic Monthly Flow in the Merced River at Stevinson for Water Years 1972-1992



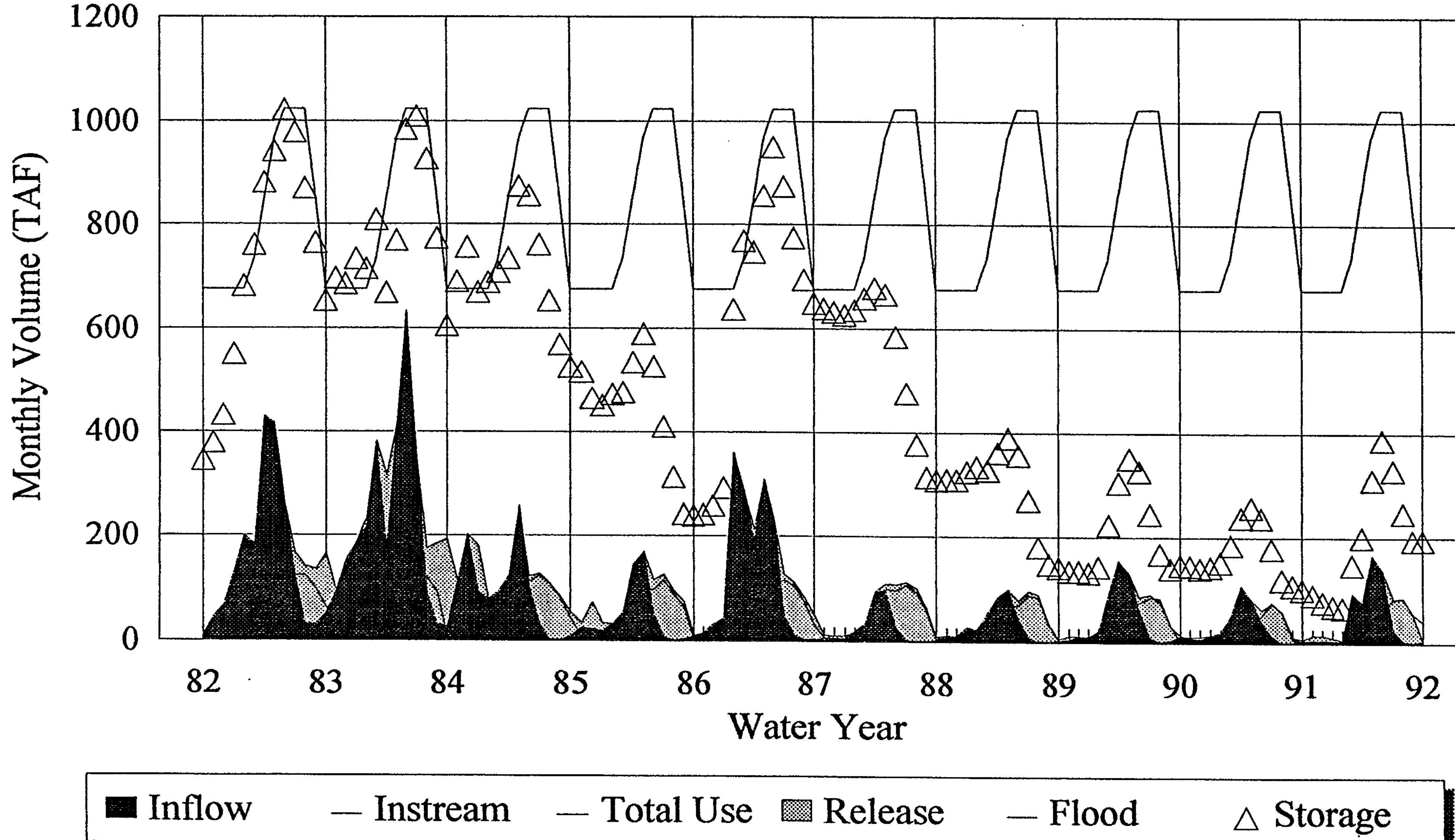
Historic Monthly Flow in the Merced River at Stevinson (cfs) for the 1972-1992 Period of Record
Average Flow = 644 cfs **Drainage Area = 1,273 sq. mi.** **Data Source: USGS**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	11	121	171	129	69	94	69	65	19	6	9	11	65
10%	38	136	190	194	205	189	139	96	60	28	19	36	89
20%	83	173	196	211	222	271	181	149	109	34	38	51	104
30%	142	205	222	231	245	294	198	157	124	94	125	152	159
40%	257	237	249	348	320	313	225	195	169	124	161	174	240
50%	390	247	296	365	457	369	298	254	203	161	164	253	253
60%	428	438	441	391	665	605	447	399	375	223	210	302	475
70%	452	544	510	624	846	891	505	618	663	231	254	368	553
80%	720	668	627	805	1,241	1,910	1,567	1,475	979	273	277	798	623
90%	1,469	740	1,170	2,826	1,336	2,964	2,665	1,697	1,416	308	385	922	988
100%	2,739	1,184	2,421	3,224	4,695	5,478	4,949	3,997	4,545	3,593	1,192	1,716	2,284

Figure 99

Merced River Flow Allocation

Historical



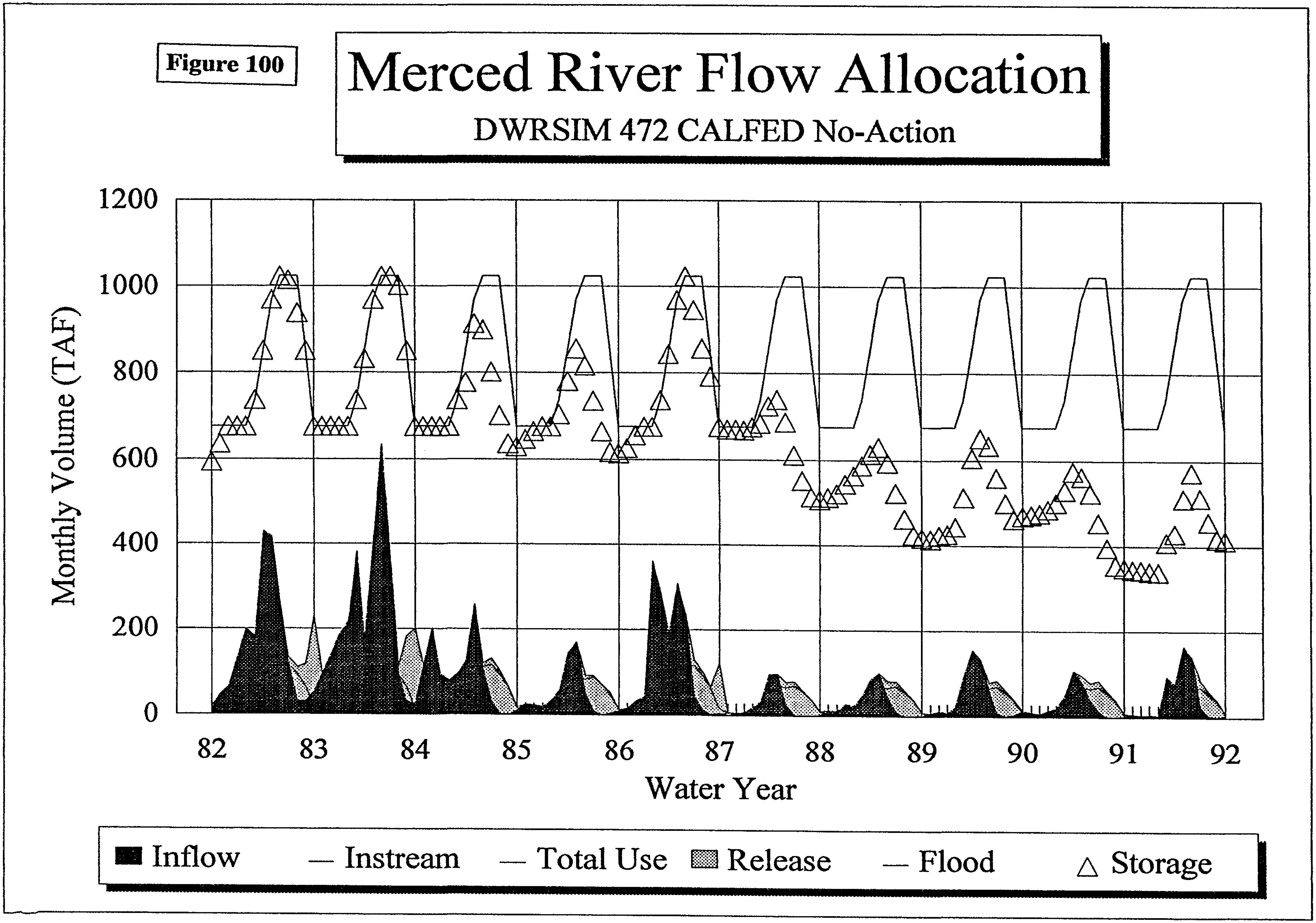
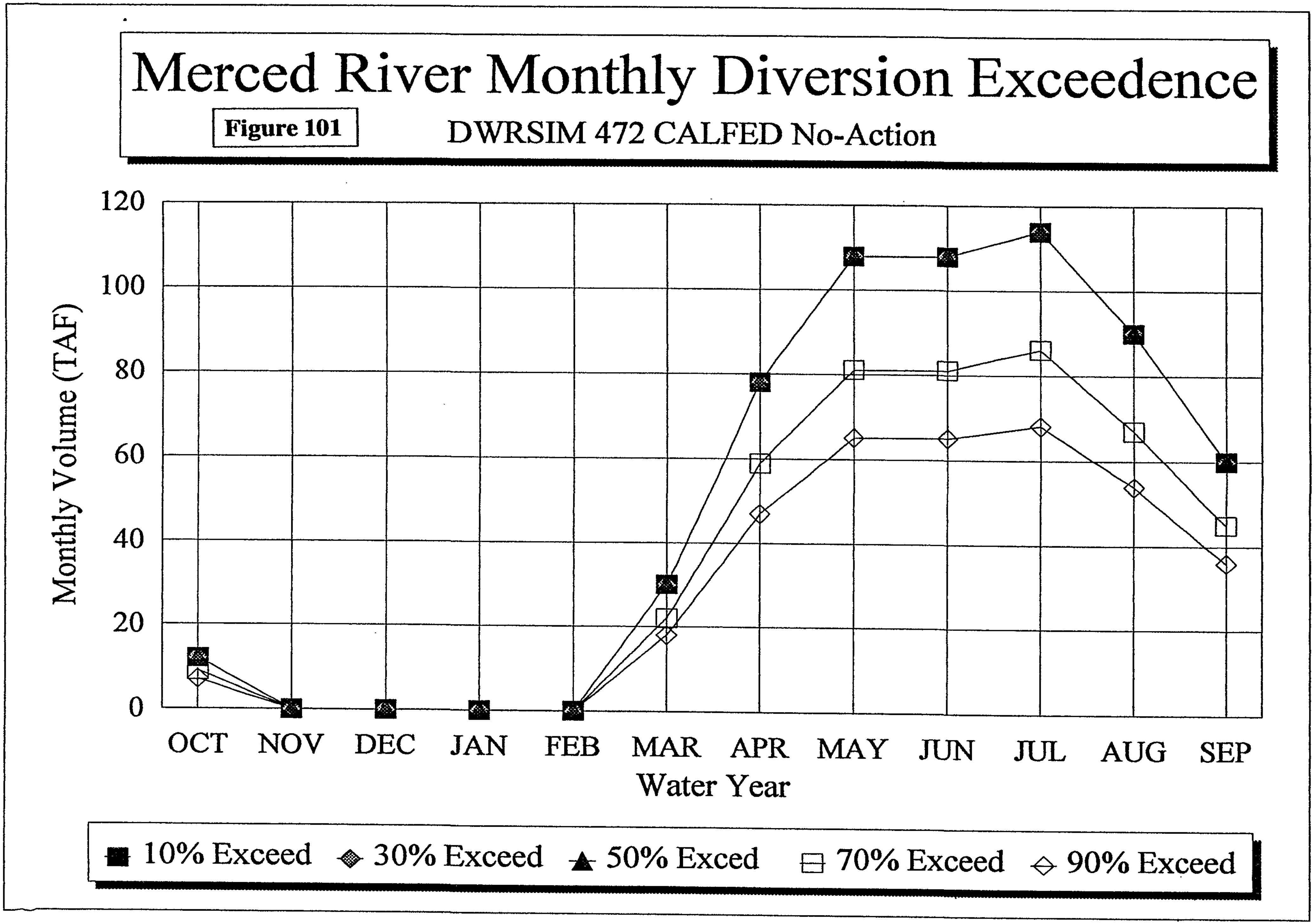


Figure 100
Merced River Flow Allocation
DWRSIM 472 CALFED No-Action
Monthly Volume (TAF)
1200
1000
800
600
400
200
0
82
83
84
85
86
87
88
89
90
91
92
Water Year
Inflow
Instream
Total Use
Release
Flood
Storage

C-003332



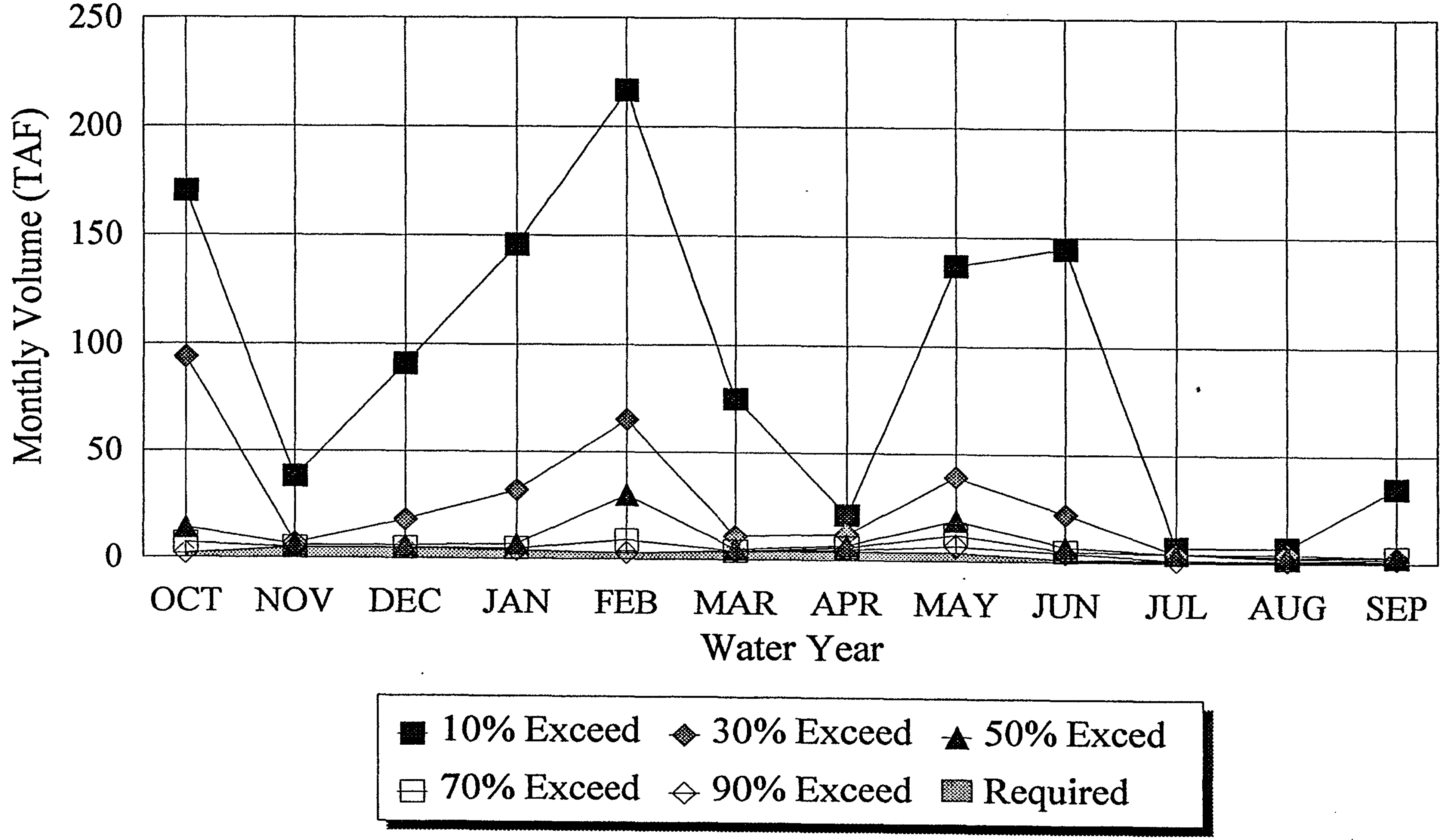
Merced River Monthly Diversion Exceedence
Figure 101
DWRSIM 472 CALFED No-Action
Monthly Volume (TAF)
120
100
80
60
40
20
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Water Year
10% Exceed
30% Exceed
50% Exced
70% Exceed
90% Exceed

C-003333

Figure 102

Merced River Monthly Flow Exceedence

DWRSIM 472 CALFED No-Action



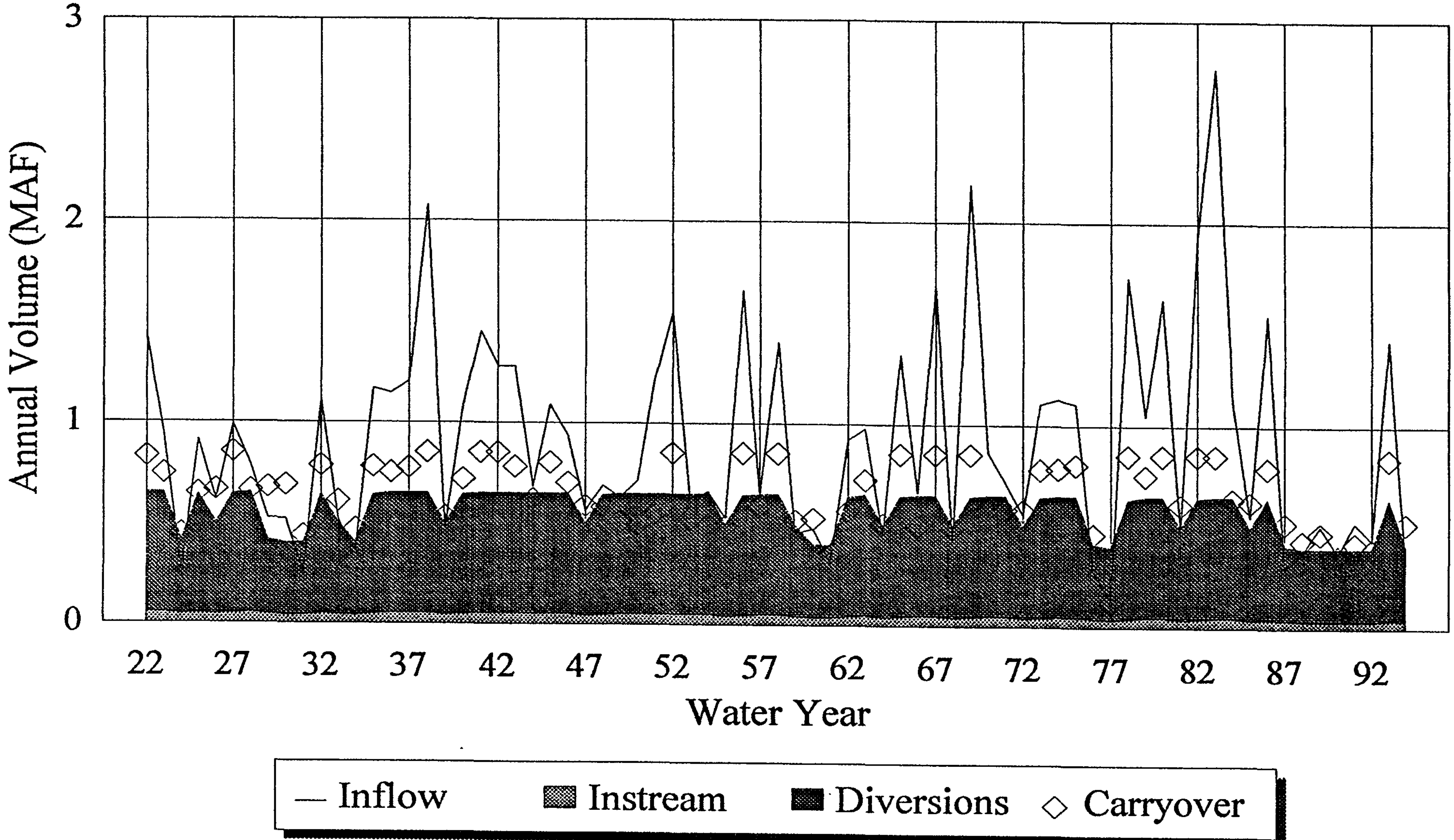
C-003334

C-003334

Figure 103

Merced River Annual Water Allocation

DWRSIM 472 CALFED No-Action

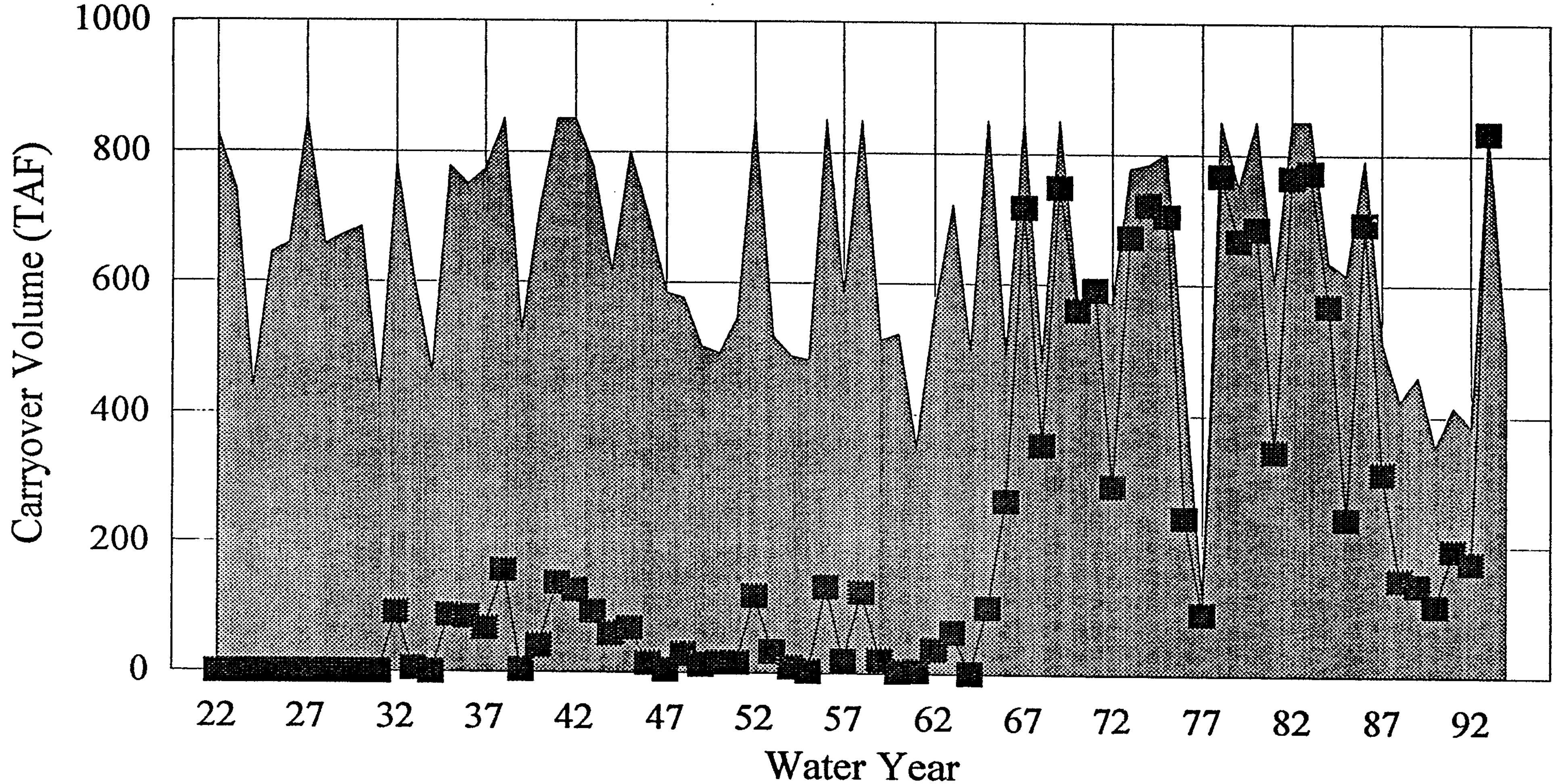


C-003335

Figure 104

McClure Lake Carryover Storage

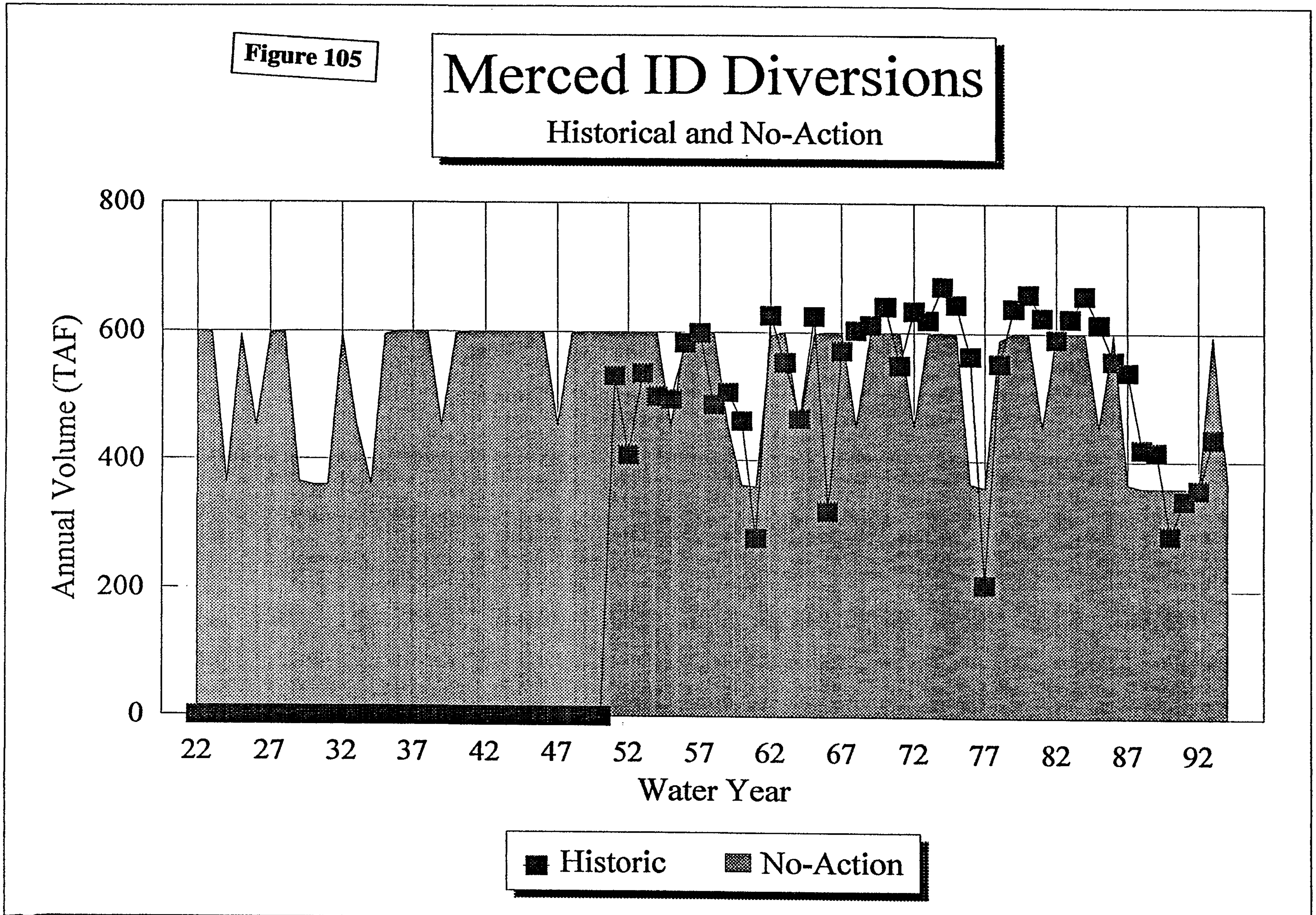
Historical and No-Action



C-003336

C — 0 0 3 3 3 6

Figure 105



C-003337

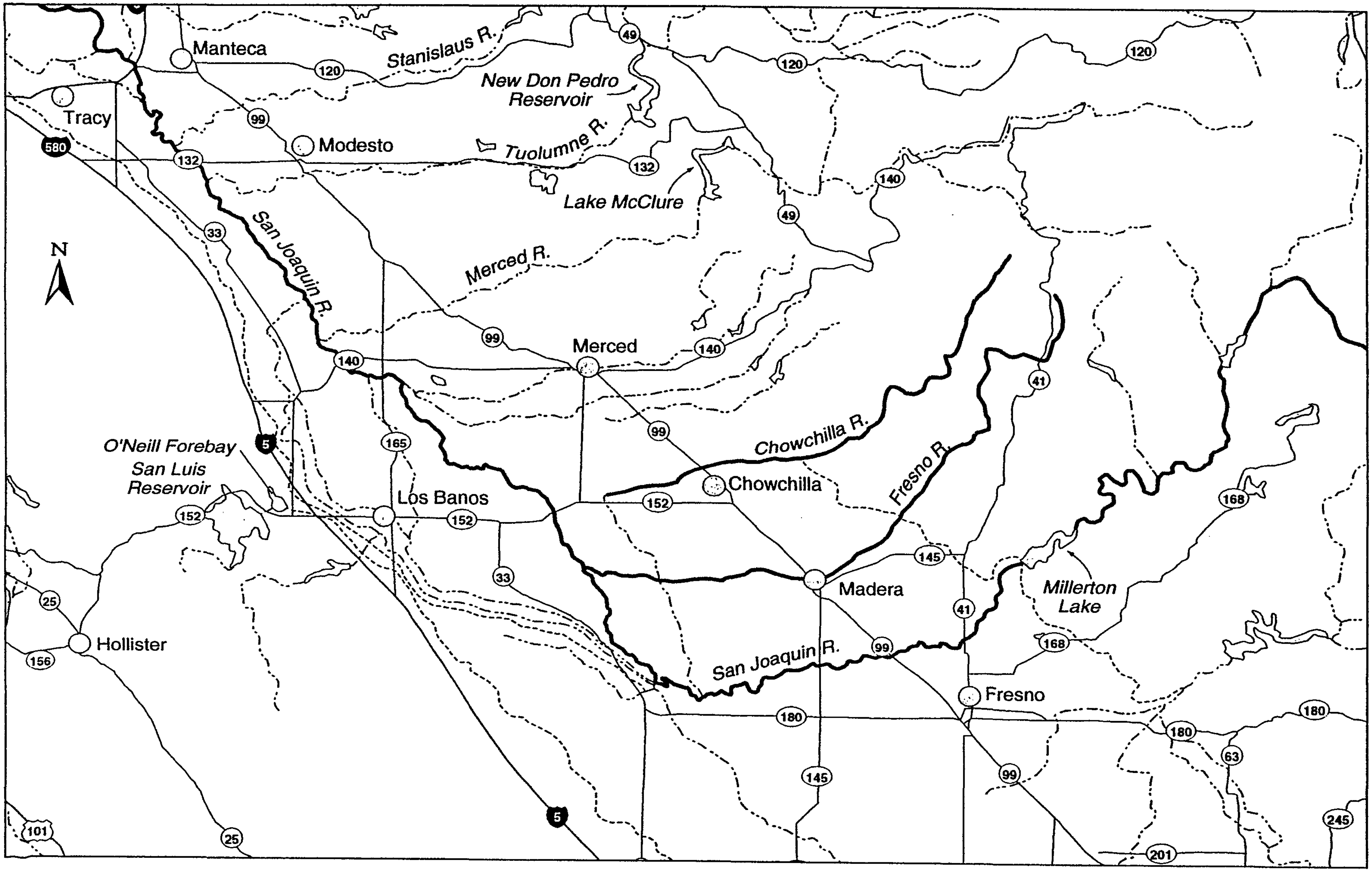


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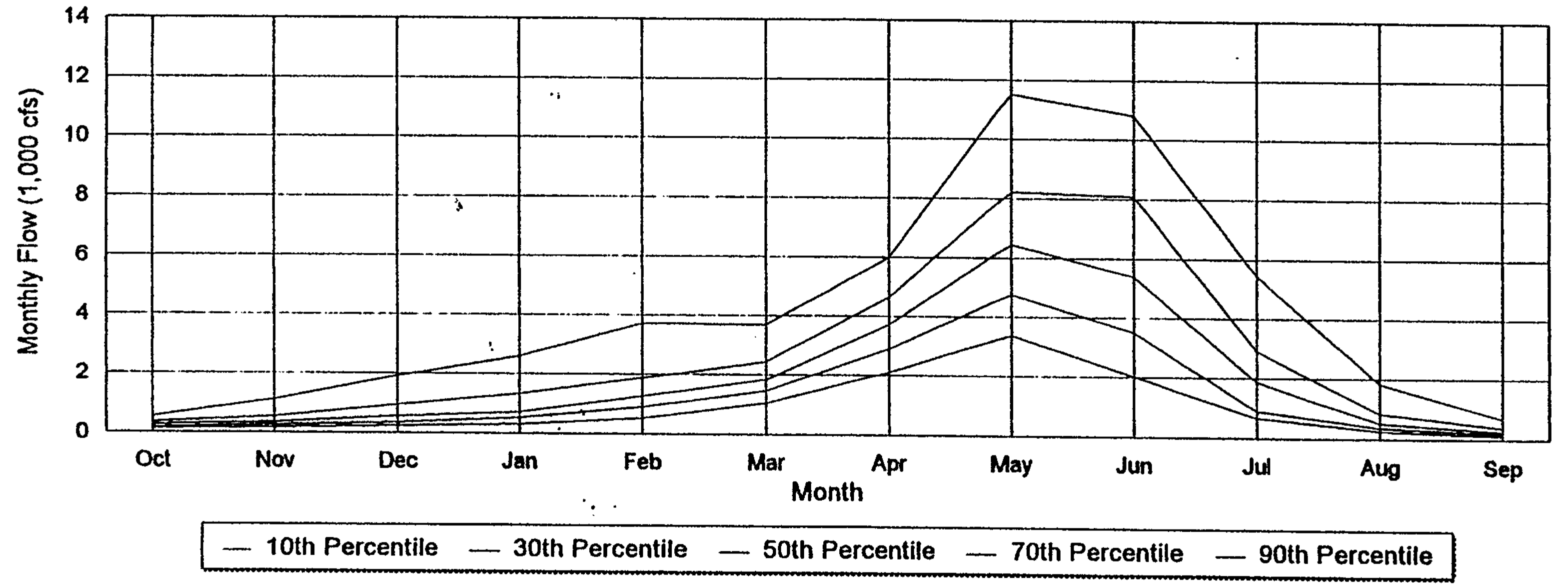
Figure 106
San Joaquin River Basin Water Management Facilities

C-003338

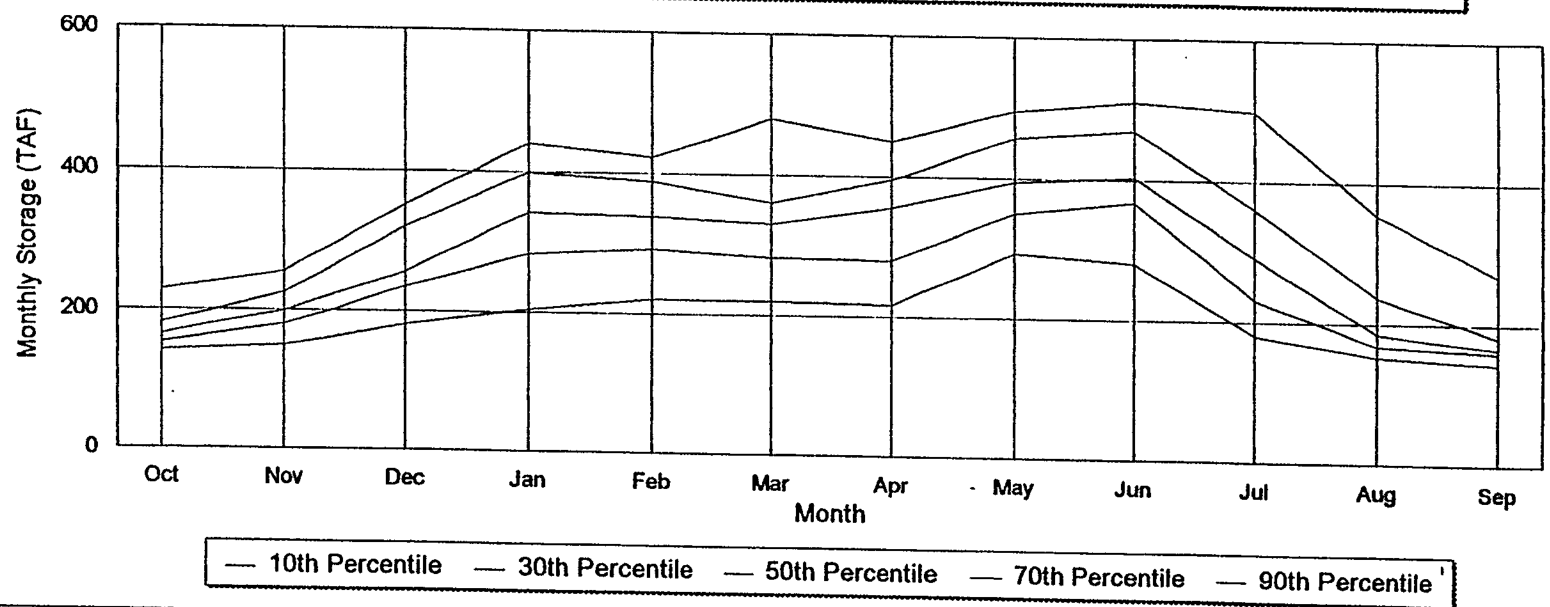
Figure 107 Distribution of Unimpaired Monthly Inflow to Millerton Lake for Water Years 1922-1992



Unimpaired Monthly Inflow to Millerton Lake (cfs) for the 1922-1992 Period of Record
Average Flow = 2,322 cfs **Drainage Area = 1,638 sq. mi.** **Data Source: DWR**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	81	101	114	163	198	309	958	1,220	588	260	146	67	361
10%	114	168	228	293	522	1,057	2,118	3,383	2,033	667	244	118	759
20%	163	202	260	358	702	1,301	2,454	3,757	2,470	716	309	151	921
30%	163	252	342	504	900	1,464	2,891	4,765	3,496	894	358	185	1,111
40%	211	286	472	602	1,026	1,675	3,395	5,660	4,504	1,431	423	218	1,214
50%	260	336	553	699	1,278	1,838	3,714	6,457	5,378	1,870	520	252	1,417
60%	293	437	699	1,008	1,621	2,098	4,168	7,546	6,117	2,374	683	319	1,846
70%	342	538	943	1,334	1,873	2,440	4,638	8,229	8,100	2,911	829	387	2,041
80%	390	672	1,301	1,805	2,773	2,944	5,109	9,709	9,663	4,310	1,155	555	2,254
90%	537	1,109	1,919	2,586	3,727	3,692	5,983	11,515	10,789	5,448	1,838	689	2,963
100%	2,049	4,151	7,497	6,440	8,499	7,058	10,302	17,825	19,595	11,157	4,554	2,857	4,642

Figure 108 Distribution of Historic End-of-Month Storage in Millerton Lake for Water Years 1952-1992



Historic End-of-Month Storage in Millerton Lake (TAF) for the 1952-1992 Period of Record
Average Storage = 292.6 TAF **Drainage Area = 1,676 sq. mi.** **Data Source: CDEC**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0%	134	139	151	175	160	146	138	198	228	166	137	139
10%	141	150	180	204	221	221	218	293	280	182	152	144
20%	148	162	212	251	241	254	262	343	317	220	159	151
30%	153	179	234	283	292	282	280	350	368	233	169	159
40%	160	188	245	304	318	307	338	365	392	269	179	162
50%	164	199	256	342	339	330	357	394	403	292	186	166
60%	168	205	285	376	370	342	373	424	442	321	199	170
70%	181	225	320	398	387	361	395	457	469	362	238	183
80%	187	237	335	413	410	422	413	473	487	436	263	197
90%	228	255	351	440	422	479	450	495	510	498	355	270
100%	325	354	467	459	470	492	495	513	526	515	477	379

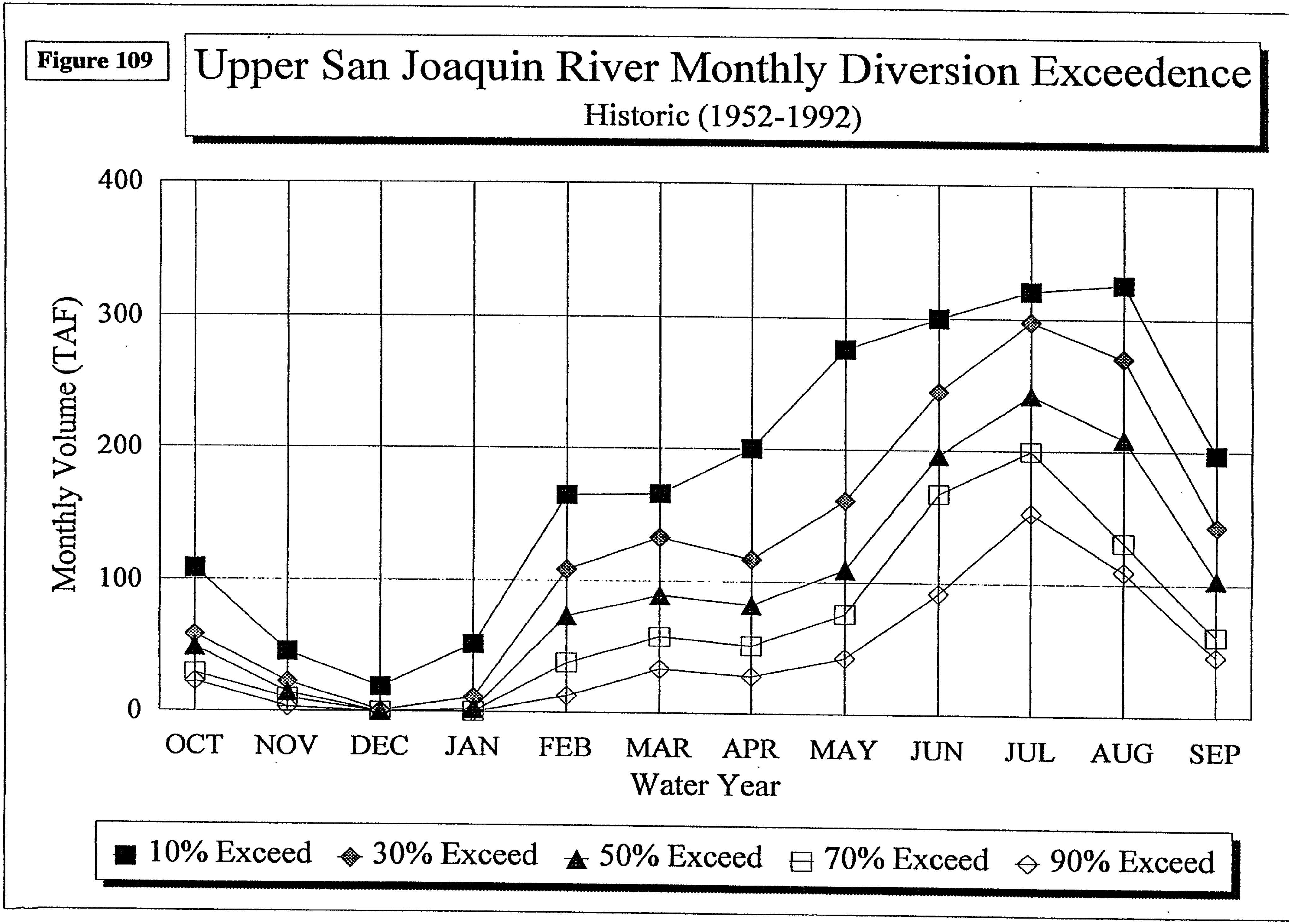
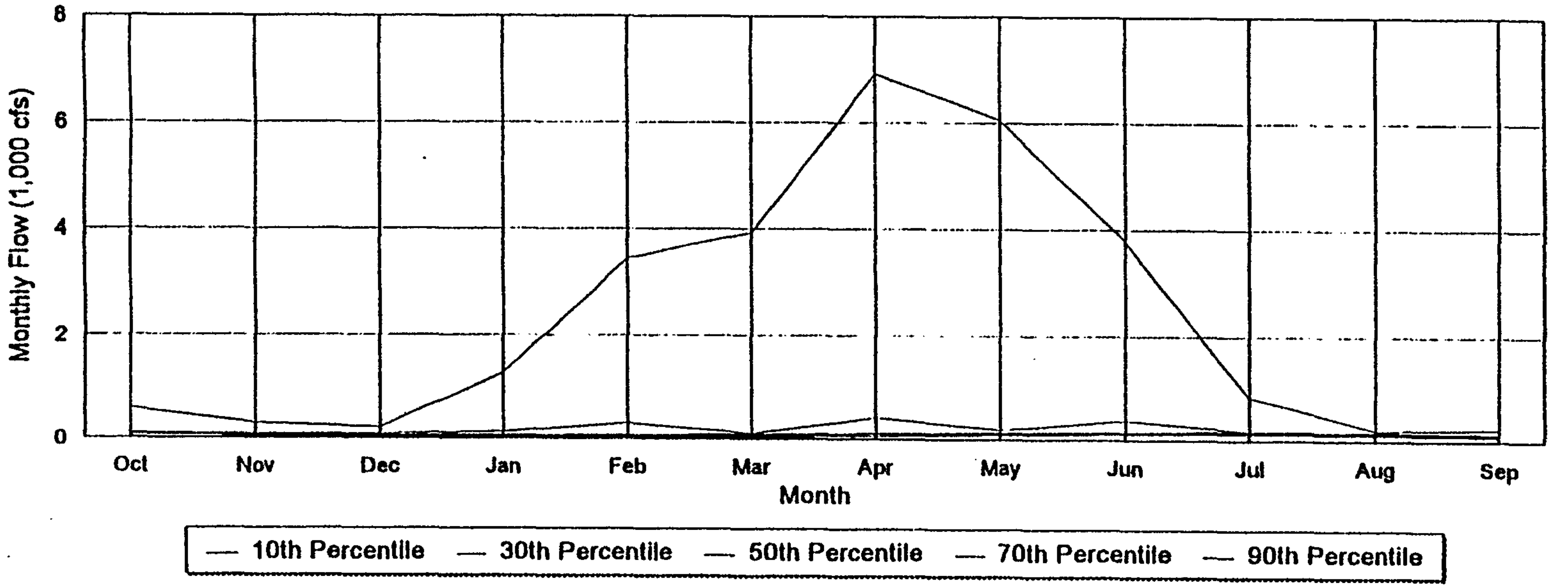


Figure 109
Upper San Joaquin River Monthly Diversion Exceedence
Historic (1952-1992)
Monthly Volume (TAF)
400
300
200
100
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Water Year
10% Exceed
30% Exceed
50% Exceed
70% Exceed
90% Exceed

C-003341

C-003342

Figure 110 Distribution of Historic Monthly Flow in the San Joaquin River below Friant for Water Years 1952-1992



Historic Monthly Flow in the San Joaquin River below Friant (cfs) for the 1952-1992 Period of Record

Average Flow = 645 cfs **Drainage Area = 1,676 sq. mi.** **Data Source: USGS**

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TAF/yr
0%	47	37	32	30	34	33	43	44	79	101	91	67	48
10%	69	51	36	35	47	47	60	94	123	137	115	89	63
20%	76	56	39	39	50	60	95	112	140	146	128	98	69
30%	82	67	49	48	57	63	111	119	146	155	134	109	80
40%	90	69	56	58	61	84	120	124	163	169	144	115	87
50%	94	75	59	66	83	98	130	147	173	178	150	120	100
60%	100	79	65	83	128	110	151	161	189	186	163	127	123
70%	114	98	97	144	315	120	437	210	397	194	183	141	285
80%	125	117	110	241	1,065	910	1,997	2,358	619	222	195	158	971
90%	591	303	236	1,283	3,468	3,928	6,909	6,064	3,792	845	215	237	1,269
100%	1,249	1,623	3,798	5,376	7,100	7,705	7,701	8,128	8,811	5,141	1,661	2,133	3,175

C-003342

Figure 111

Upper San Joaquin River Flow Allocation

Historical

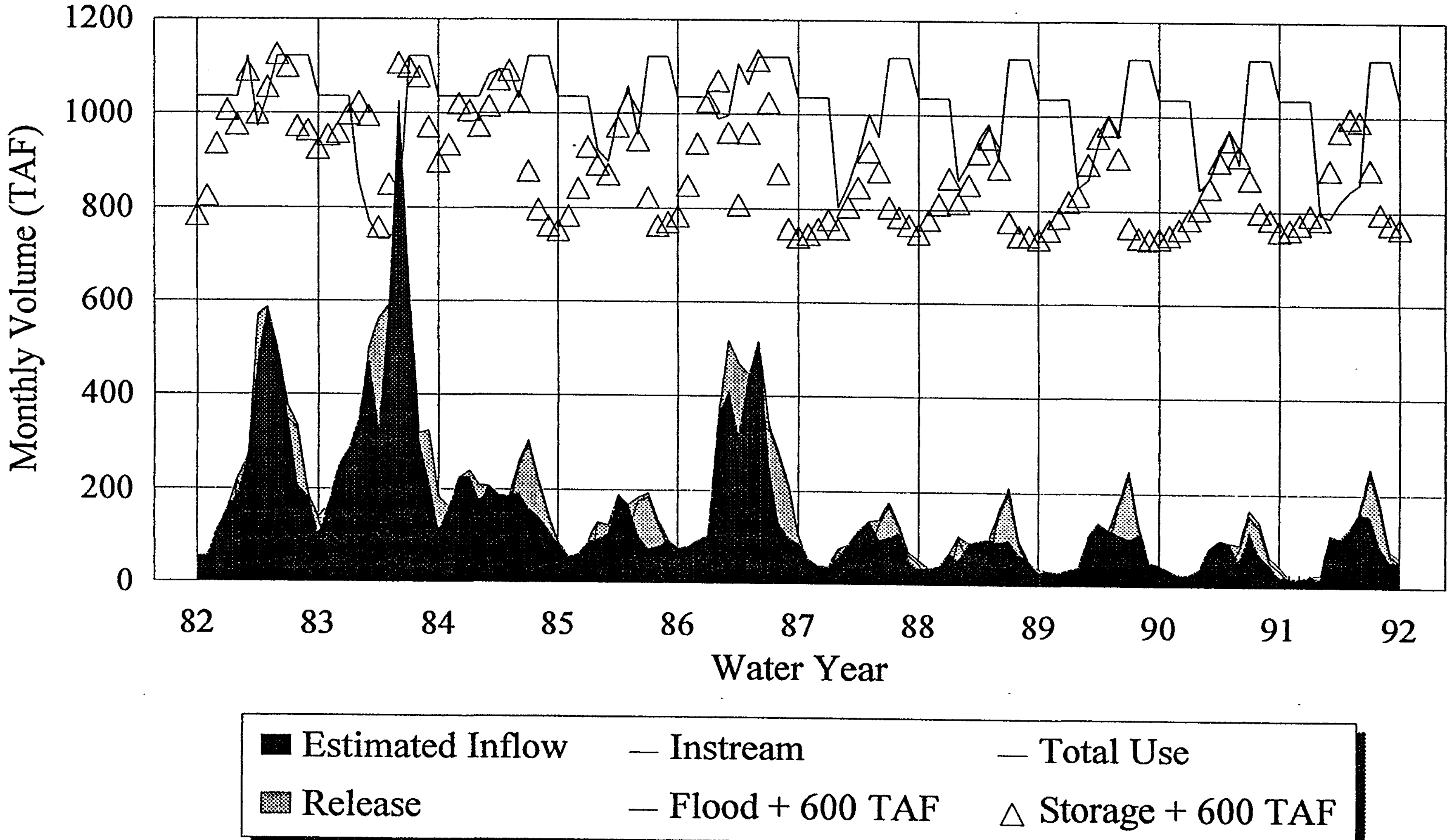
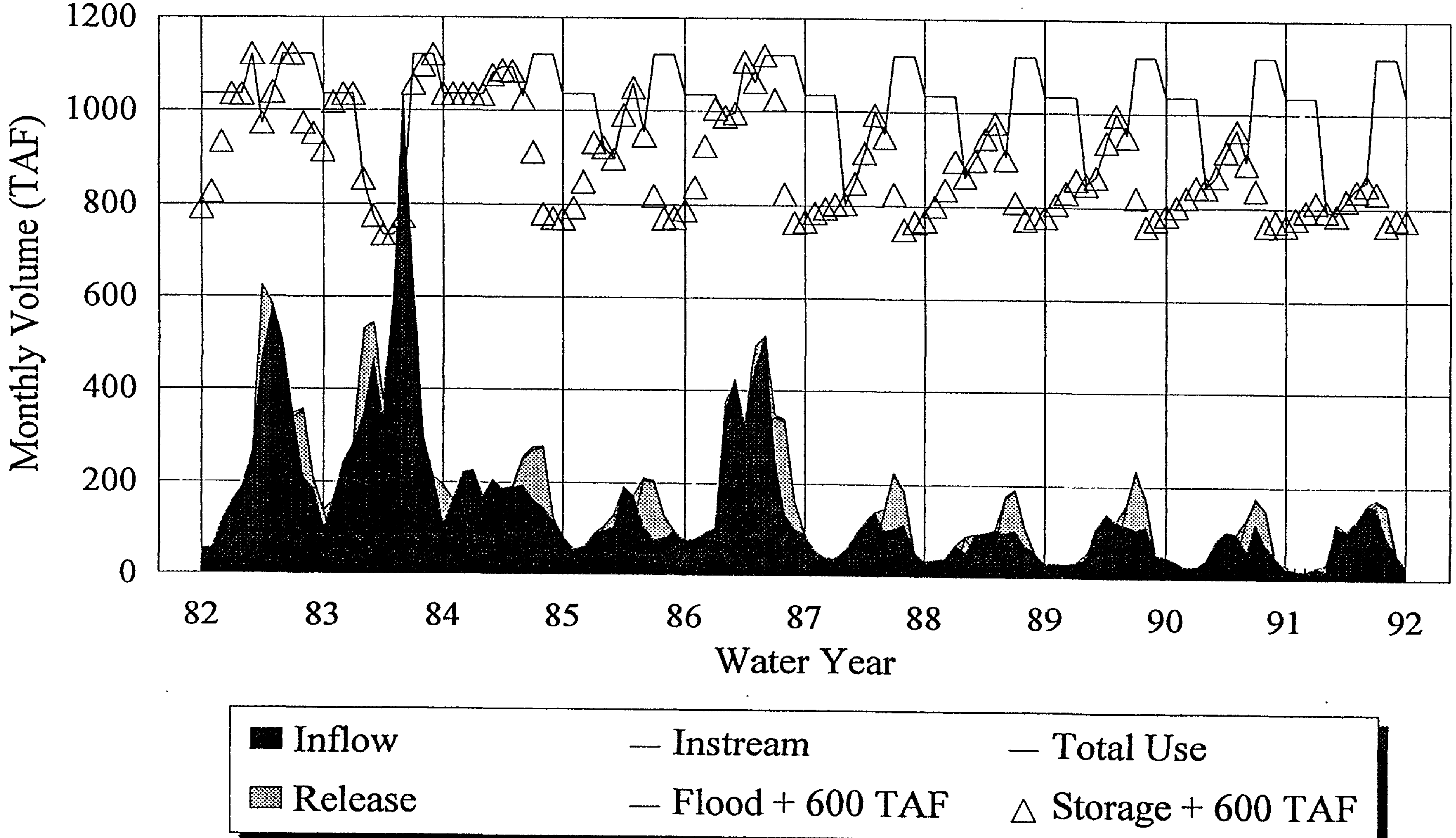


Figure 112

Upper San Joaquin River Flow Allocation

DWRSIM 472 CALFED No-Action

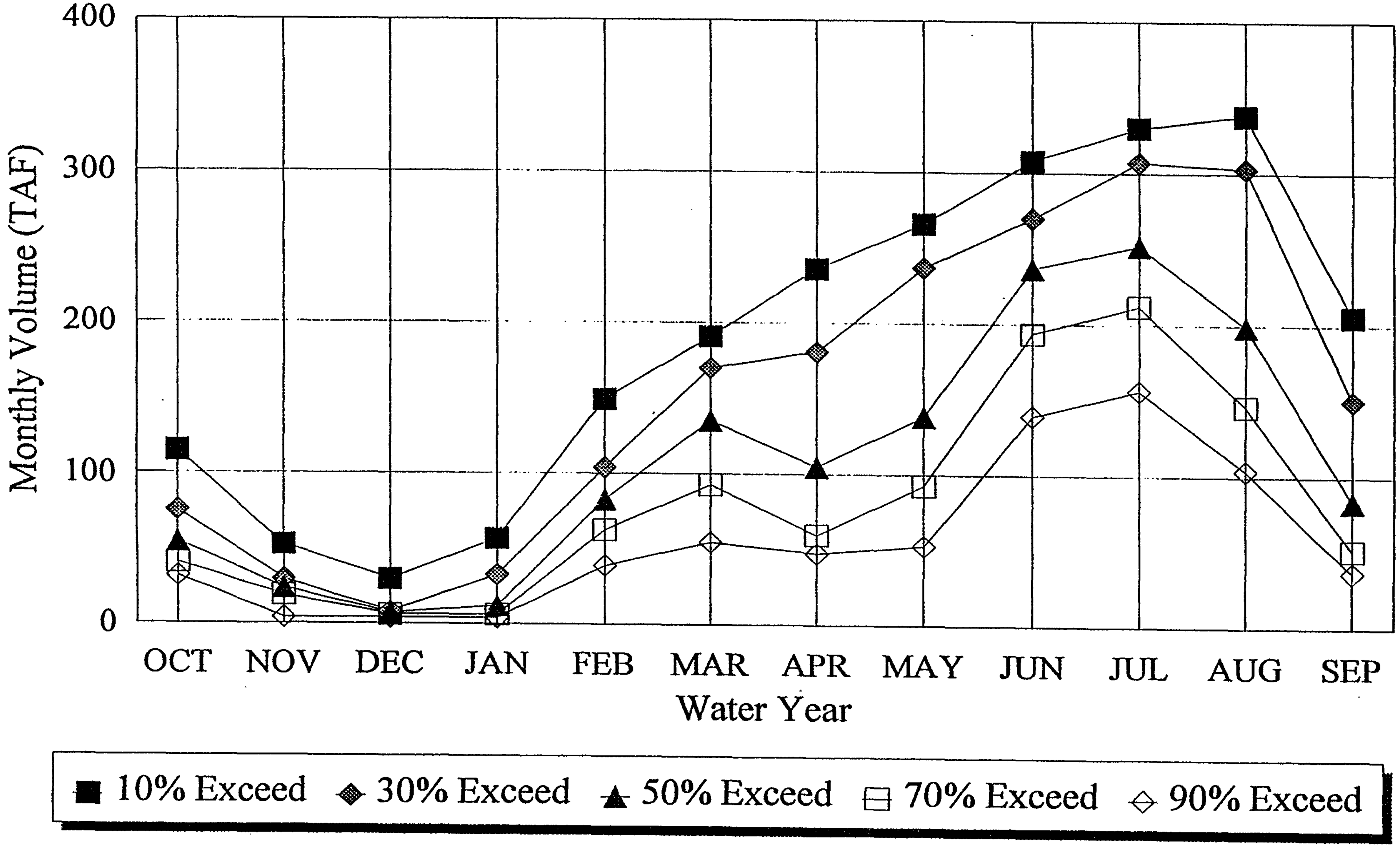


C — 0 0 3 3 4 4

Figure 113

Upper San Joaquin River Monthly Diversion Exceedence

DWRSIM 472 CALFED No-Action



C-003345

C—003345

Upper San Joaquin River Monthly Flow Exceeden

DWRSIM 472 CALFED No-Action

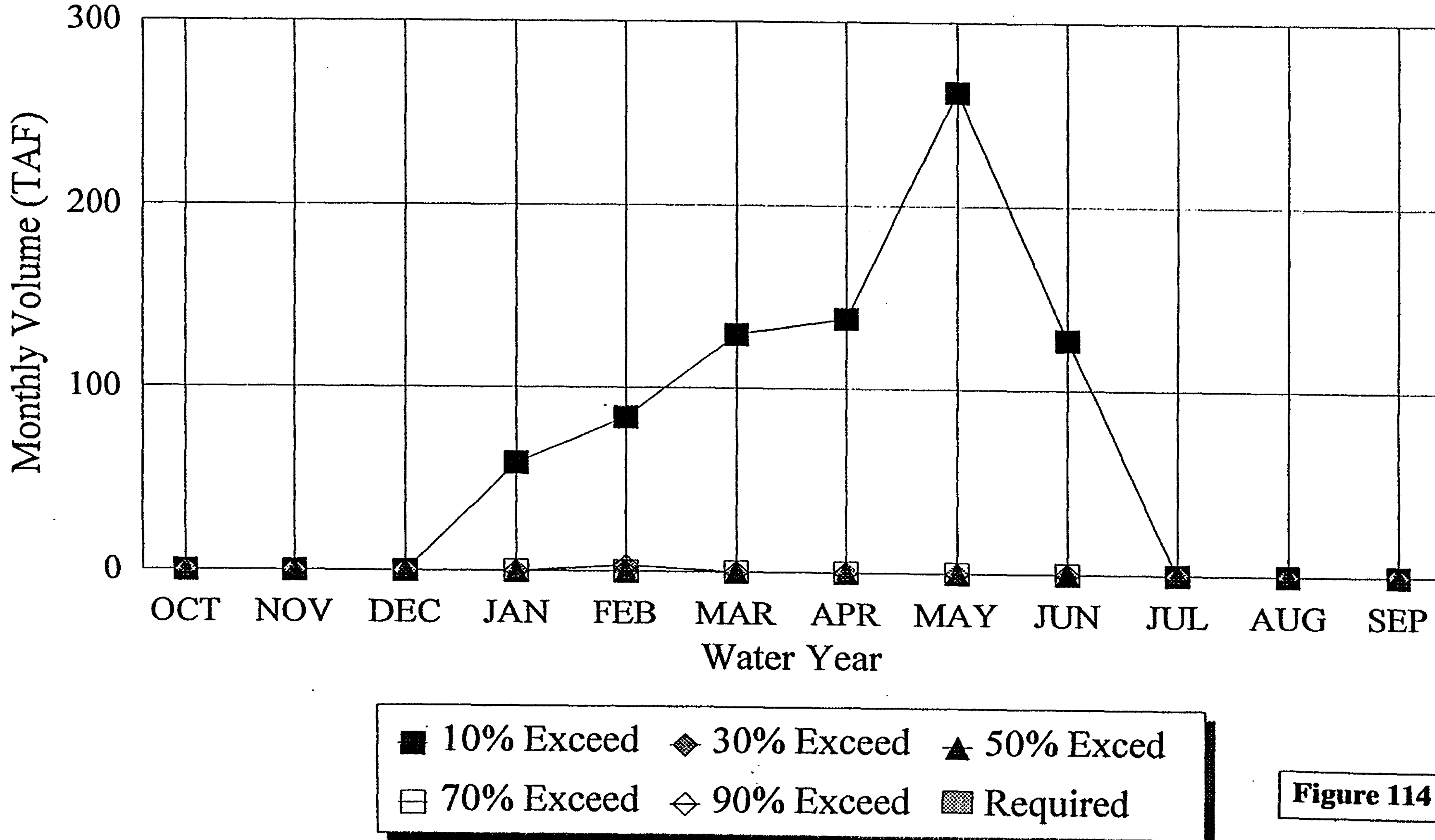
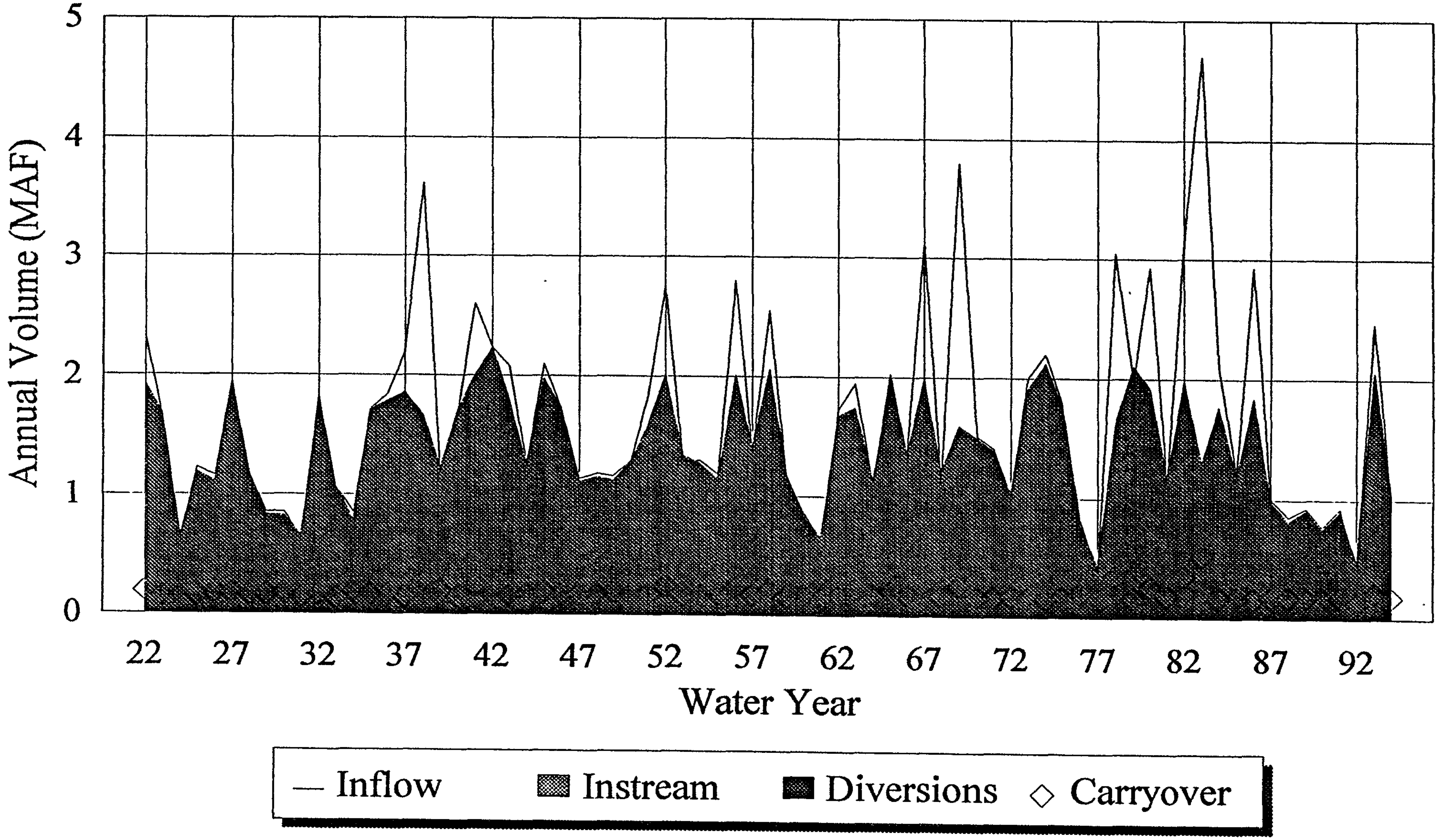


Figure 114

Upper San Joaquin River Annual Water Allocatio

Figure 115

DWRSIM 472 CALFED No-Action



C-003347

C—003347

Figure 116

Millerton Reservoir Carryover Storage

Historical and No-Action

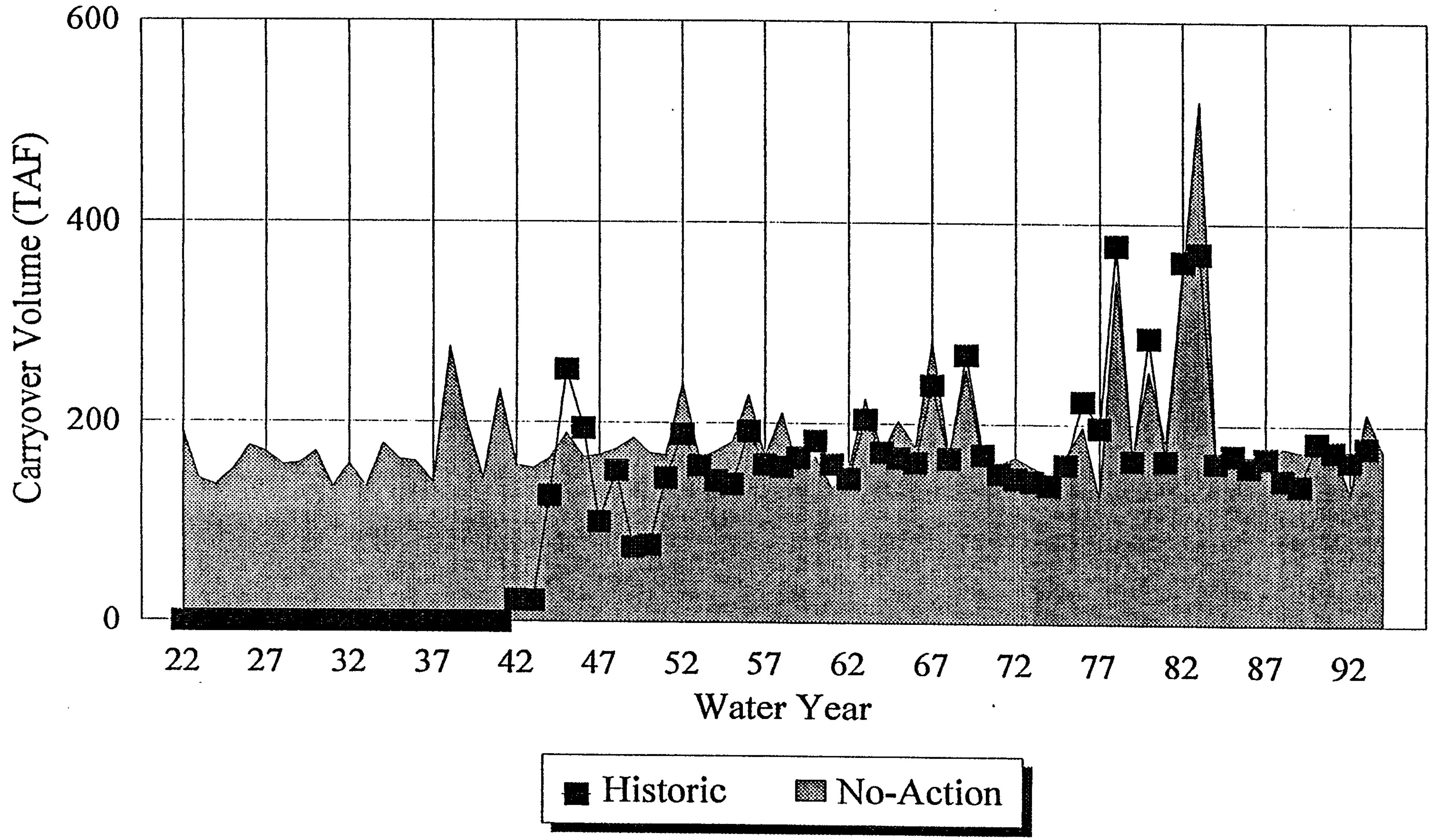
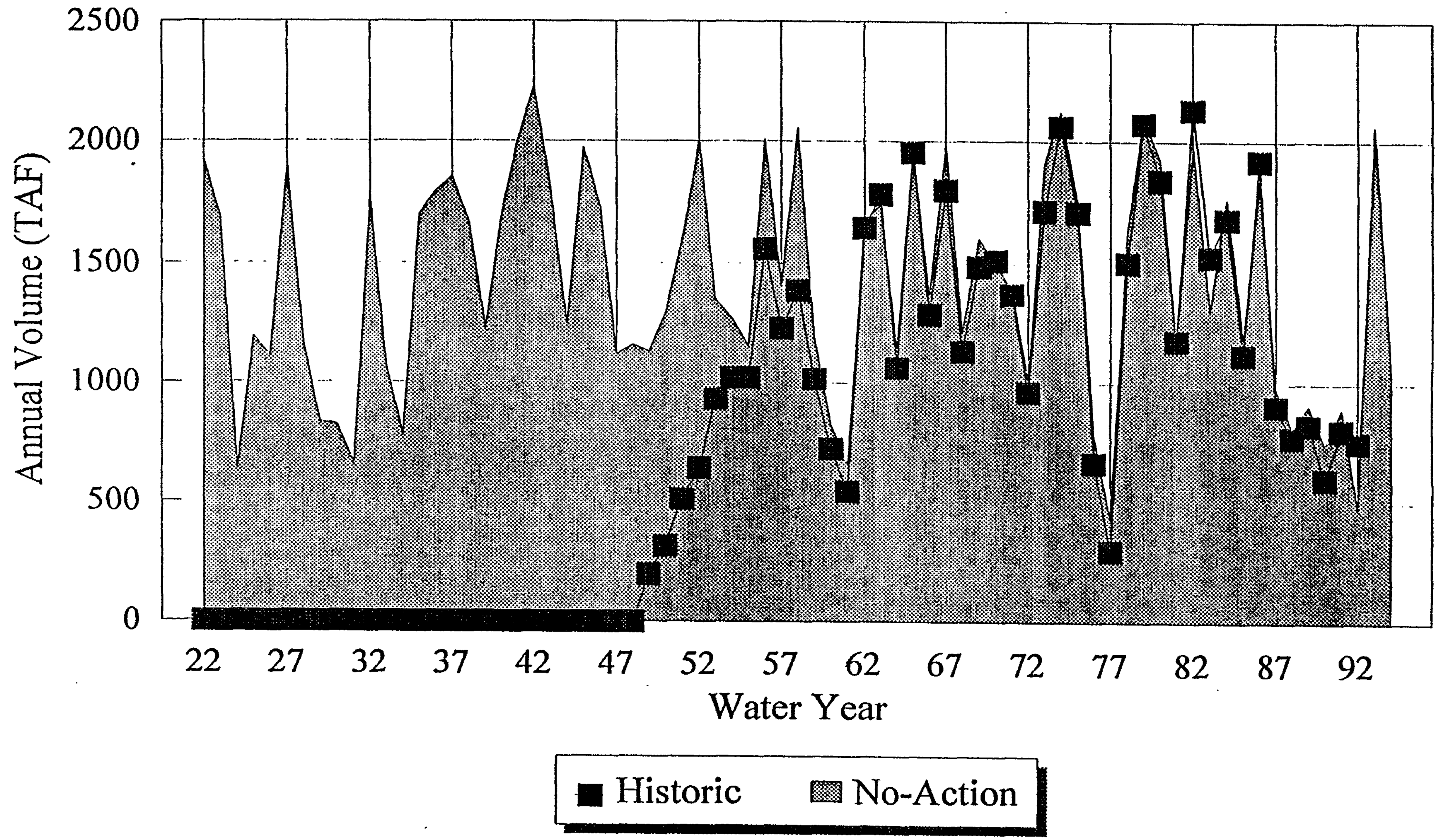


Figure 117

Upper San Joaquin River Diversions

Historical and No-Action



C-003349

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